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ABSTRACT

This report is the result of a seven-month study by the ad hoc Planning Commission for Expanding Minority Opportunities in Engineering charged with developing guidelines to increase participation of underrepresented minorities in the engineering profession. Following a report summary and recommendations, Chapter 2, the progress of minorities through the educational system, reviews the history and current status of each of the four underrepresented minority groups in the American educational system. Chapter 3, engineering education and minorities in engineering, provides a comprehensive overview of the process by which engineering students of all races are educated in the United States. Chapter 4, educational goals and measures of progress, sets forth the task force's proposed goal of equality in enrollment and retention among all students being educated as engineers. Chapter 5, mechanism for progress, discusses the financial requirements as well as the possible sources of financial support for the additional minority engineering students called for throughout the report. (Author/MJM)

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Minorities in Engineering

A BLUEPRINT FOR ACTION

A REPORT BY

The Planning Commission
for Expanding Minority Opportunities in Engineering

Louis Padulo, *Chairman*
Percy Barron
Calvin H. Conliffe
Donald G. Dickason
David E. Ford
Austin E. Greaux
David B. Kent
W. Edward Lear
Delano Meriwether
Joseph E. Milano
Micah H. Naftalin
David R. Reyes-Guerra
Lindon E. Saline
Willis Spratling
Clement W. Theobald
Seth H. Washburn
John C. Williams

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Preface

This report is the result of a seven-month study by the *ad hoc* Planning Commission for Expanding Minority Opportunities in Engineering, an independent Task Force charged with developing guidelines to increase the participation of underrepresented minorities in the engineering profession.

The Reasons for this Study

During the past few years there has developed a broad interest by diverse groups in bringing racial and ethnic minorities into more meaningful participation in engineering. Many different organizations are already attempting to make individual or collective progress toward accomplishing that result.

Several industrial and educational leaders have called for the establishment of national objectives such as ten- to fifteen-fold increases in the supply of minority engineering graduates within the next decade. Other groups have announced similar goals in levels of employment and in engineering college enrollments. But as yet there has been no real overview of the situation. There has been no in-depth analysis, for example, of the proposed goals of ten- to fifteen-fold enrollment increases. (In fact, which goal is more reasonable? How large an increase is required and in what time frame can it be realized?) Nor is there any blueprint for implementing the very general recommendations.

This study undertook such an overview. Specifically, the present report:

1. Defines a numerical goal for minority representation in engineering education, with specific targets for individual minorities, to be reached by a certain time;
2. Weighs the feasibility of this overall goal;
3. Analyzes the principal steps which should be taken to achieve it;
4. Estimates the costs of the principal steps;
5. Identifies the agencies which could carry out specific programs; and
6. Outlines procedures for measuring progress toward the goal.

In May, 1973 more than 250 engineering educators, students, industrialists, government officials, and minority leaders attended the Symposium on Increasing Minority Participation in Engineering, convened by the Commission on Education and the National Academy of Engineering. The symposium participants called for a "national mobilization" to ensure that minorities be brought up

to equitable participation in engineering within a decade. The present report is intended to facilitate such a mobilization by directing the efforts of those individuals and organizations involved into the most productive channels.

The Organization of this Study

This study was conceptually simple even though the lack of reliable data on both minority education and engineering education made it difficult to carry out certain phases of the investigation satisfactorily.

1. An advisory Task Force representing minorities, education, industry, professional organizations, and the federal government was selected to provide a broad, general input, to guide the study, and to prepare recommendations for action.
2. The Task Force met four times between December and May. The first meeting laid guidelines for the overall study. The second and third reviewed progress and designated areas for special additional investigation. At the fourth the Task Force reviewed the overall report and drew up the final recommendations.
3. Three special sessions involving subunits of the Task Force were also held. A special two-day workshop devoted to Chicanos and Puerto Ricans was held in January. Several Task Force members met with representatives of the Society for the Advancement of Chicanos and Native Americans in Science, Aspira, LULAC, and other Mexican American and Puerto Rican organizations to identify the particular needs of these minorities. Members of the finance committee met to prepare preliminary recommendations regarding the national scholarship organization finally called for by the Task Force. Some of the finance committee members also met with consultants to review special problems involved with providing student aid.
4. The Task Force and staff conducted mail and telephone surveys to determine the status of current minority engineering programs, the potential interest of industry in supporting minority engineering programs, and the importance of transfer students in engineering colleges.
5. The Task Force and supporting staff examined past data and future projections regarding the U. S. population, numbers of engineering students, and numbers of engineering degrees in order to develop specific, year-by-year numerical goals for freshmen entering engineering which would ultimately lead to proportionate representation of each minority in the engineering profession.
6. Where possible, the staff examined the flow of each minority through the educational pipeline which produces engineers with baccalaureate degrees. The purpose was to discover where potential engineers leave the pipeline—in other words, where barriers to educational opportunity exist. This enabled the Task Force to decide where efforts and investments would be most effective.
7. The Task Force and staff drew up specific recommendations, priced

them, defined the responsibilities of various organizations in carrying them out, and listed them in priority order.

Acknowledgements

The Planning Commission Task Force acknowledges a special debt of gratitude to the Alfred P. Sloan Foundation and to Stanford University. The Sloan Foundation provided both the encouragement and the funding for the establishment of this Task Force. Through an initial planning grant from Sloan in December 1973, the Task Force set out to prepare its report for March 1974 distribution and paced itself accordingly. When in early March it became clear that the Task Force had identified important issues for further study, and that there was mounting national interest in having a comprehensive blueprint for the diverse groups concerned with minorities in engineering, the Sloan Foundation encouraged the Task Force to expand its study and provided the funds for the additional effort resulting in this report. In particular, Dr. Percy Pierre, Program Officer in charge of Sloan's own minority engineering programs and Dean of Engineering at Howard University, proved to be an insightful, thoughtful resource person and contributed greatly to the understanding of the Task Force members. Executive Vice President Robert N. Kreidler was a patient, supportive influence, sharing Sloan's experiences with programs to increase minorities in medicine and in business, and encouraging us to prepare a report which would be useful to a broad spectrum of interested groups. Vice Presidents Stephen White and Arthur Singer, and Program Officer James Koerner contributed welcome suggestions concerning the organization and distribution of the final report and the small pamphlet abstracted from it. Stanford provided encouragement, office space and facilities. Provost William Miller, Dean William Kays and Department Chairman John Linvill juggled teaching schedules around so that the Task Force chairman could devote half time to this project; Dr. Bernard Nelson and Dean Arjay Miller gave much-appreciated advice on the selection of staff and project management; and Dr. James Meindl, Director of the Stanford Electronics Laboratories, and Annamae Calhoun promptly cut through any red tape concerning equipment and office space.

The Task Force and its staff are also indebted to many individuals and organizations who contributed unselfishly of their time and resources, answered our questions and pointed us in the right directions. These contributors deepened our understanding of the problems of increasing minority participation in engineering and provided us with the necessary data bases from which to formulate and evaluate proposed solutions.

John D. Alden, of the Engineering Manpower Commission of the Engineers' Joint Council shared with us both his data on engineering and minority enrollments and his wisdom concerning the use of that data. Elaine H. El-Khawas of the Center for Human Services and Ann S. Bisconti of URC Management Services Incorporated made available preprints of their as-yet-unpublished studies on educational patterns and achievement and on transfer students from two-year to four-year colleges. Dorothy M. Knoell of the Califor-

nia Coordinating Council on Higher Education dug back into her files to help us understand transfer students into engineering colleges.

Jeannie T. Rover of the American Council on Education provided us with many ACE reports and advice on carrying out our own computer analyses on educational data. Professors Bernard Roth and John Gill studied minority population data and engineering enrollments. Professor John Gill and Mr. Clodoaldo Barrera programmed and ran the Task Force analysis of engineering attrition and transfer patterns on a data bank graciously provided by Arthur Marmaduke of the California State Scholarship and Loan Commission. Edmund C. Jacobson of the College Entrance Examination Board, and free-lance programmer Bill Van Dusen provided timely free advice.

Professors Frank Brown of SUNY-Buffalo and David Lavin of CUNY-Lehman provided us with copies of their reports on minority education and open admission programs, and Mr. Frederick Shaw of the New York City Board of Education and Mr. David Lopez of Aspira kept us up to date on Puerto Rican enrollments at the college and precollege levels.

Dr. George B. Lane of the Federal Interagency Committee on Education (FICE) generously made available preliminary results of that task force's study on higher education for Chicanos, Puerto Ricans and American Indians and guided us through the different data bases of HEW and the federal government. Messrs. Martin M. Frankel and Vance Grant, both in the U.S. Office of Education, shared the latest college enrollment and degree projections and the forecasting techniques of their agencies.

Mr. Dorrance Steele, Assistant Executive Director of the National Advisory Council on Indian Education, and Ms. Beverly Letchworth, of the National Academy of Engineering, provided us with data and networks of resource persons knowledgeable about Indian education. Dr. George Castro, Professor James Leckie, Messrs. Angel Rivera, David Lopez, Clodoaldo Barrera, and Jose Villalobos participated in a two-day workshop with the Task Force subcommittee on Chicano and Puerto Rican concerns and made valuable suggestions to the Task Force. Dr. Richard Griego, Mr. Roberto Finnell, Mr. Gerard Perez and Mr. Luis Alvarez, Executive Director of Aspira, also contributed to our understanding of special problems confronting Chicano and Puerto Rican students.

The Planning Commission had the good fortune to have its office on the campus of Stanford University where there is a large community of minority engineering students from diverse geographical and educational backgrounds. From October 1973 through February 1974, the staff participated in a weekly seminar and discussion group with students, faculty, engineering employers and practicing engineers from the entire Bay Area and many inputs and perspectives from those meetings influenced this report. Three student organizations in particular: the Society of Black Scientists and Engineers (SBSE) at Stanford University, the Stanford Society of Chicano Engineers and Scientists (SSCES), and the Black Engineering and Science Students Association (BESSA) at U.C. Berkeley, should be singled out for their initiatives in approaching the precollege and counseling aspects of minority science education, and students from SBSE designed our cover. Student researchers Lois Corrin and Giovannae

Dennis provided a female perspective. Ms. Corrin compiled data on Black education, Ms. Dennis conducted the telephone survey resulting in Appendix B, and Mr. Wyatt Isabel conducted the survey of industry interest in minority engineers which helped us to formulate funding policies for minority programs. Mr. Clodaldo Barrera analyzed both Chicano and Indian education and engineering attrition, and Mr. Robert Alvarez reviewed the drafts of the Puerto Rican and Chicano sections of Chapter 2.

The Task Force was blessed with an exceptionally competent staff: Sandra Dyer, our administrative assistant, Mr. Douglas Barker (on loan from the Engineering Societies Committee for Manpower Training), Giovannae Dennis (on loan from IBM), Dr. Martin Weiner (on loan from the Office of the Dean of Undergraduate Studies at Stanford), and Pat Bastein. Educational consultants Dr. Robert R. Hind of the Academy for Educational Development and Mr. Samuel J. Moffat proved extremely valuable in their interactions with the Task Force, eliciting from the members vague suggestions and ideas and returning to them carefully worked out analyses and working drafts. They, along with Ms. Dyer, were in every sense working members of the Commission and helped to shape this report.

In addition, the numerous minority engineers, educators, businessmen and directors of minority programs from all parts of the country who responded to our questionnaires, returned our telephone calls, repeated the answers to our questions until we finally understood them, and helped us to ask the right questions of others, have all contributed immensely to the preparation of this report. We hope it justifies their efforts.

Finally, the members of the Task Force and its staff thank their spouses and families for putting up with all of the out-of-town meetings, late night phone calls, and after-hours work which accompanied the preparation of this report.

1

Summary and Principal Recommendations

Racial and ethnic minorities in the United States now have substantially greater opportunities for education and entry in several professions than they had a few years ago. One important profession in which they are still underrepresented, however, is engineering.

In 1970 only 2.8% of the engineers in the United States were Black, Chicano (Mexican American), Puerto Rican, or American Indian[1] although these four minorities constituted 14.4% of the U. S. population at that time. In 1973 we estimate that 5.1% of the freshmen enrolled in U. S. engineering colleges were Black, Chicano, Puerto Rican, or American Indian.[2] While the numbers of these four minorities enrolling as freshmen in engineering colleges increased by nearly 80% between 1970 and 1973,[3] it is obvious that they are still severely underrepresented in American engineering and engineering education.

THE FOUR UNDERREPRESENTED MINORITIES

After considering the status of various minority groups in engineering, the Task Force decided to restrict its recommendations to the four underrepresented minorities named above. Available data show that although they may be underrepresented in other professions, Oriental Americans—including those of Chinese, Japanese, Filipino, and Asian Indian origin—are not underrepresented in engineering. John Alden of the Engineering Manpower Commission of the Engineers Joint Council states that "Orientals have long been prominent in U. S. engineering schools and in many branches of the profession."[4] He estimates that 2.9% of U. S. engineers are Orientals, while these minorities in 1970 represented 1% of the population. There are, nevertheless, members of these other minority groups who are educationally and economically disadvantaged and who should be sought out by employers and engineering schools as part of a comprehensive minority program.

Although the four underrepresented groups with whom our report deals do not include all the minorities defined as such for purposes of federal affirmative action programs, our selection of them does not conflict with federal or state regulations. These regulations require government contractors and subcontractors, including educational institutions, to provide equal employment opportunities for women and minorities, and to establish affirmative action programs to accomplish these goals. These principles should also apply to the selection and retention of students. Federal guidelines define minorities as Negroes, American Indians (including Eskimos and Aleuts), Orientals, and Spanish-surnamed Americans (those of Mexican, Puerto Rican, Cuban, or Spanish origin).[5] All of these groups should of course be fairly represented in the engineering profession and in the student body. We simply take the view that the most pressing problem is that of achieving equitable representation for Blacks, Chicanos, Puerto Ricans, and American Indians.

We also believe that a heavy representation in engineering of one minority as legally defined (Orientals, for example) cannot be used to satisfy the larger responsibility of providing equitable participation of truly underrepresented minorities. Nor do we believe that the confusion arising from the U. S. Supreme Court's recent refusal to rule in the case of Marco De Funis, Jr.,[6] (a white student who charged reverse discrimination when he was denied admission to the University of Washington Law School) justifies any delay in the recruitment of minority students into engineering. There is sufficient room in engineering schools that minority enrollment could be multiplied several times without taxing the schools' capacity. Moreover, Justice William O. Douglas in his dissenting opinion on the De Funis case suggests that a student's social and economic background, including past deprivations, can be weighed in considering his admission. Because so many minority students have been deprived as a result of racial discrimination, their admission under present or even future interpretations of the law should present no legal problems.

The Task Force also considered the totally inadequate representation of women in engineering, but decided not to try to deal with it. We recognize the need to overcome the barriers that in the past have limited the number of women in engineering, and we wholeheartedly support the efforts of other groups that are addressing the problem.

We have focused our attention on the four designated minorities for the following reasons:

Black Americans

Of all racial and ethnic minorities in the United States, Blacks (or Negroes or Afro-Americans) are the most poorly represented in the engineering profession. John Alden estimates that in 1970 only 1.2% of the members of the engineering profession were Black, while Blacks made up 11.1% of the U. S. population. On simple numerical grounds Blacks have a compelling claim on our attention.

Chicanos and Puerto Ricans

Alden's data at the Engineering Manpower Commission suggest that Spanish-surnamed Americans are somewhat better represented in engineering than Blacks (1.6% in the profession, 4.4% in the population). But he estimates that about 45% of these are immigrants from Latin American and other Spanish-speaking countries. This suggests that Americans of Spanish descent born in this country are more poorly represented than the average indicates. An analysis of the educational attainment of Spanish-surnamed Americans shows that Chicanos and Puerto Ricans fall far below the U. S. average, and below the averages for other Spanish Americans, in educational attainment (Table 1-1).

TABLE 1-1

College Education of Americans of Spanish Descent Aged 25 Years and Older

POPULATION	PERCENTAGE WITH SOME COLLEGE	PERCENTAGE WITH 4 YRS. OF COLLEGE OR MORE
(1)	(2)	(3)
Cuban	24.7%	12.7%
Central or South American	24.5%	11.2%
TOTAL U. S. POPULATION	21.3%	11.0%
Spanish Other Than Four Groups Listed Here	19.8%	8.7%
Chicano	6.4%	1.6%
Puerto Rican	5.6%	2.4%

SOURCE: 1974 World Almanac, p. 316, from November 1969 Current Population Survey, U. S. Bureau of the Census.

The Task Force concluded that since Chicanos and Puerto Ricans are so poorly represented among the college educated, they must also be seriously underrepresented in engineering education.

American Indians

Data for American Indians are less adequate. Alden cites a 1972 survey of the Institute of Electrical and Electronics Engineers in which 0.55% of the

members were identified as American Indians, and assumes the same proportion would be found throughout the profession. But he believes that "the number drawn from the reservation Indian population is undoubtedly much smaller." In 1970 American Indians made up 0.39% of the U. S. population. Given the generally poor career opportunities for American Indian youth, the Task Force believes that Indians should be included in the effort to improve minority representation in engineering.

Throughout the remainder of this report, unless specifically indicated otherwise, the term "Blacks" will refer to Black Americans, "Chicanos" to Mexican Americans, and "minorities" to Blacks, Chicanos, Puerto Ricans, and American Indians—the four underrepresented minorities in engineering.

RECENT EFFORTS TO DEAL WITH THE PROBLEM

The need to increase minority representation in engineering was strongly and succinctly brought to the attention of a large professional audience, perhaps for the first time, in an address on July 25, 1972 by J. Stanford Smith of the General Electric Company.[7] Speaking at the Engineering Education Conference, he said:

> Of 43,000 engineers graduated in 1971, only 407 were Black and a handful were other minorities or women. One percent. It takes about fifteen to twenty-five years for people to rise to top leadership positions in industry. So if industry is getting one percent minority engineers in 1972, that means that in 1990, that's about the proportion that will emerge from the competition to the top leadership positions in industry . . .
>
> Gentlemen, this is a formula for tragedy. Long before the year 1990, a lot of minority people are going to feel that they have been had. Already there are angry charges of discrimination with regard to upward mobility in industry, whereas the real problem, clearly visible today, is that there just aren't enough minority men and women who have taken the college training to qualify for professional and engineering work . . .
>
> To put the challenge bluntly, unless we can start producing not 400 but 4,000 to 6,000 minority engineers within the decade, industry will not be able to achieve its goals of equality, and the nation is going to face social problems of unmanageable dimensions . . .
>
> The only acceptable solution is to take bold, innovative, all-out action to increase the supply of minority engineering graduates not by a few percentage points, but ten- or fifteen-fold, and to get it done within the decade. This is the only way we can expect to see acceptable proportions of minority men and women in the top ranks of industry by the end of the century.

One of the first groups to respond to this urgent recommendation was a task force, now known as ME³ (the Minority Engineering Education Effort), organized in December 1972 with the sponsorship of the Engineers Council for Professional Development and representing engineering societies, pre-college counselors and teachers, community liaison groups, the media, and industry.[8]

This group made its ultimate goal a 10- to 15-fold increase in minority engineering graduates by the mid-1980's. The group also adopted two short-range objectives—a 50% increase over the 1972 minority enrollment among freshmen entering in 1973, and a 100% increase by 1974.

Despite its late start in the school year, ME³ was able to reach more than 8,000 minority high school graduates in the class of 1973 who were interested in engineering and related fields, and more than 2,500 community college students, providing them with information about the profession and about 115 engineering schools interested in enrolling minorities. This effort contributed importantly to the enrollment increases that occurred between 1972 and 1973. As our report was being written, a similar program was under way for the class of 1974, and ME³ had identified 17,000 minority high school graduates and 1,500 community college students for referral to an expanded list of 180 engineering colleges interested in enrolling minority students.

A second group to heed the call for increasing the number of engineers from minority groups was made up of several hundred persons—educators, students, government officials, industrialists, philanthropists, and representatives of minority social action groups and professional and technical societies—who attended the Symposium on Increasing Minority Participation in Engineering that was sponsored by the Commission on Education at the National Academy of Engineering (NAE) in Washington, D.C., on May 6-8, 1973. The symposium participants agreed unanimously on "a national goal of achieving a ten-fold increase in minority engineering graduates from 500 to 5,000." It was the consensus of the participants "that this was a reasonable goal, provided the necessary resources could be marshalled on the national and regional levels."

The symposium delegates urged NAE to take "a leadership role in seeing that continuing attention is focused on the problem and that the goal is attained." In the 12 months following the symposium, the Academy has in fact done just that. Acting upon the recommendations of symposium participants, it participated in the creation of a National Advisory Council on Minorities in Engineering (NACME), which includes representatives of minority groups and persons from the highest levels of industry, government, and education. In addition, NAE has established its own working Committee on Minorities in Engineering (COME), has recruited a professional staff to direct this effort, and has already raised some of the funds with which to support a sustained program.

A few months after the symposium, the Academy conducted a survey of existing minority programs and published its findings in the document, *Proceedings of the Symposium on Increasing Minority Participation in Engineering.* It is apparent from the *Proceedings* that many efforts are now under way to attract minority engineering students and help them once they are in school. Programs at more than 20 educational institutions are described in the *Proceedings,* along with projects involving professional societies, industry, and other organizations.

A third group to call attention to the problem was the American Association for the Advancement of Science (AAAS) which at its annual meeting in Februrary 1974 devoted several symposia to the problems and opportunities involved in motivating and training minorities in science. These discussions also

gave attention to the matter of interpreting college board exams in relation to Chicano and Indian students; to improving the quality of science education for minorities; and to the need for increased support for graduate programs for minorities.

Still a fourth group to address the problem of minorities in engineering is the Education Group of the Institute of Electrical and Electronics Engineers. It devoted the entire February 1974 issue of its journal, *IEEE Transactions on Education,* to the subject. That document, together with the *Proceedings* of the NAE symposium, should provide the reader with a comprehensive view of the situation as of the time that our study began.

THE CASE FOR MINORITIES IN ENGINEERING

One might well ask whether the engineering profession will be performing a public service if it succeeds in attracting large numbers of minorities into the field. There are the obvious moral, legal, and social arguments that can be made, but the layoffs in recent years in the defense and space industries serve as a reminder that engineers are not always in demand. If there are not sufficient jobs for new minority engineers when they graduate, their earlier frustrations will be aggravated.

We believe that the outlook in engineering for employment is highly encouraging. Indeed, there may be shortages of engineers in the future; some observers have even suggested that an increasing amount of America's engineering work may have to be carried out abroad. Still, we recognize that manpower predictions are extremely hazardous. Each student of engineering manpower has his own method for calculating supply and demand. Such calculations, with the resulting predictions of too many or too few people in the field, are in one sense misleading. Frederick E. Terman, former dean of engineering and now vice president and provost emeritus of Stanford, has commented that

> . . . there is no such thing as a surplus or shortage of engineers; rather, there is always one job for each engineer. What varies with economic conditions is the quality of the job opportunities.[9]

In good times, interesting and desirable jobs may be plentiful; in lean times, the new graduate may have to work hard to find a job, and the job he finds may not be as interesting or desirable. But there will almost certainly be a job.

That is the long view. A shorter view over, say, the next ten years suggests, according to most manpower experts, that there will be a steady increase in the number of engineering jobs available and an increasing demand for engineers in many specialties.[10]

Even conservative manpower predictions have special meaning for minorities. During the "depths" of engineering unemployment in 1970–72, although there were pockets where unemployment exceeded the national average, the overall rate of joblessness never exceeded 3% in engineering.[11] This

figure might be compared to the overall U. S. unemployment rate of almost 6% in the same period.[12] Even more significant is a comparison of the 3% peak in engineering with the overall unemployment rate of non-whites, which was 10% in 1971 and 1972, or roughly twice as high as that among whites during the same period.[13] Any profession in which unemployment does not exceed 3% and is usually closer to 1% (it was 1.4% in the decade 1963–1972) should be very attractive to racial and ethnic minorities accustomed to far higher rates of joblessness.

Furthermore, minority students with the proper educational qualifications, or who can qualify for admission after remedial work, will find many schools anxious to admit them. This is not just a matter of new social consciousness on the schools' part, although that is a factor. The fact is that there is a lot of room for students in engineering schools today. Freshman engineering enrollments across the nation dropped nearly 30% between 1969 and 1974.[14] Accordingly, the schools have considerable unused capacity. Even if a resurgence of interest in engineering were to restore enrollments to their 1969 levels, competition for admission to engineering schools would still not be as intense as that for admission to medical schools, for example. The job outlook, then, is good and there is ample room in engineering schools for more minority students.

Are there any other reasons why minorities should enter engineering? Two further reasons are excellent pay and real opportunities for advancement in the profession. The salaries offered bachelor's degree candidates in 1974, according to the College Placement Council, were consistently higher for engineering students than for those in any other field. The average was $964 a month in eight fields of engineering, $821 in seven other scientific fields, including the health professions, and $786 in the humanities, social sciences, and three fields of business.[15]

There is no question that engineering can enable previously disadvantaged students to move relatively quickly into well-paid work in professional fields. Engineers earn good livings with only bachelor's degrees, while some other fields require master's or doctor's degrees before their graduates become well-paid. Along with the high salaries, a valuable fringe benefit is the arrangement whereby an engineer can work in his profession and go to graduate school part-time, usually at his company's expense. (A master's degree has become increasingly important for individuals interested in the most challenging problems in engineering design, development, and application, but a doctorate is not essential except in the academic world and for advanced industrial research.)

An engineering degree often opens the door to advancement in management, where minorities are also underrepresented. In the manufacturing industries, 50 to 60% of new employees with college backgrounds come from engineering; and it is from this pool that the vast majority of management personnel are drawn.[16] In fact, about half of the industrial managers in this country have a degree in engineering or a closely allied technical field.[17] A promising way to increase the number of minorities in management, therefore, is to train more minority engineers.

If an engineer wishes to work in still other fields outside engineering, he will find good jobs open to him. Over the years, 15% of those with undergraduate degrees in engineering have worked in fields other than engineering.[18] Employers use engineers in sales and operations, for example, because they find that engineers are trained to think analytically, to get work done on schedule, and to deal with problems quantitatively.[19] Persons with engineering degrees are also favored candidates for other graduate programs. For example, **a bachelor's degree in engineering is the single most desirable undergraduate degree for applicants to leading schools of business.**[20]

Still another reason that engineering is a worthwhile career for minority men and women is that many of the problems engineers will confront in the last quarter of this century are problems with which minorities are personally familiar: problems of housing, sanitation, transportation, and pollution. Engineers have always prided themselves on the contributions their profession makes to human welfare. The coming generation of engineers may face even greater challenges than its predecessors, especially in the central cities.

But there remains the question of whether those who employ minority engineers will take full advantage of their capabilities. The answer to this question should be an unequivocal yes—for reasons of enlightened self-interest quite apart from the fact that federal affirmative action programs require those doing business with the government to provide equal opportunities for minorities. First, the new minority engineers will represent an additional group of trained people available at a time that they are urgently needed. Second, the excellent education these individuals will bring to their jobs will also make them attractive for promotion to management positions, thereby reducing some of the tension that has developed in many businesses where minority members have been confined to lower level jobs because of their limited education or training. Third, greater minority participation in business should improve business opportunities by increasing sales to minority markets, both in this country and abroad.[21]

There is, in brief, a strong case for a major program to attract minority men and women into American engineering. A vigorous program would aid the minorities themselves, the educational institutions they attend, and the businesses which employ them.

AN OVERVIEW OF THE REPORT

Chapter 2, "The Progress of Minorities through the Educational System," reviews the history and current status of each of the four underrepresented minority groups in the American educational system. An attempt is made to identify the bottlenecks and obstacles that block their educational progress and that must be overcome to make engineering education accessible to these groups. The chapter shows that there is a substantial pool of college-bound Black students who might be attracted to engineering, but that any significant

growth in the numbers of Mexican Americans, Puerto Ricans, and American Indians entering the profession will depend upon a marked improvement in the precollege education of these minorities.

Chapter 3, "Engineering Education and Minorities in Engineering," provides a comprehensive overview of the process by which engineering students of all races are educated in the United States. It includes an analysis of the large number of students (more than half of all freshmen entering engineering) who first enroll in junior colleges, or four-year colleges without engineering programs, and who transfer into engineering colleges as upper-division students. The traditional shortcomings of the system by which engineers are trained are discussed as are the problems of attracting, motivating, and retaining engineering students in general. Specific aspects of these problems as they relate to minority students are considered. It is shown that the average length of time for engineering students (as a group, not only minorities) to complete the bachelor's degree is almost five years; that remedial programs, special tutoring, and counseling improve the performance of all students regardless of ethnic or educational background; and that better articulation between nonengineering institutions and engineering schools to improve the retention of transfer students is an obvious way to increase minority engineers. An assessment is made of the current status of minorities in engineering programs, and those institutions producing the largest numbers of minority engineers are recognized and listed.

Chapter 4, "Educational Goals and Measures of Progress," sets forth the Task Force's proposed goal of equality in enrollment and retention among all students being educated as engineers. The goal is translated into percentages and numerical targets for engineering colleges and related educational systems in order to attain population parity, or 18% representation, for the four specified minorities in the freshman engineering class by 1982. After demonstrating that this goal is reasonable, the Task Force makes realistic estimates of the manner in which the necessary growth in freshman engineering enrollments can be realized. This projected growth is then broken down into year-by-year levels against which engineering colleges may gauge their own progress. While the primary emphasis of Chapter 4 is on engineering colleges, attention is also given to the setting of goals for other institutions—precollege, non-engineering colleges, and graduate schools of engineering—that have a vital role to play in making the larger effort that we envision succeed. It is shown that unless successful precollege programs can double the size of the pool of college-bound minority youth who are attracted to engineering in high school, we can only hope to achieve about a 9% minority representation in engineering—only half of the necessary 18% for equitable participation.

Chapter 5, "Mechanisms for Progress," points out that in order to successfully attain the enrollment goals set out in Chapter 4, many things must be done, and done well, on a national level. A survey is made of the agencies and organizations now in existence which may be expected to play important roles in a national effort to increase minorities in engineering, and the need for effective coordination is recognized. Because of the clear-cut critical need for financial aid

for the additional minority engineering students, a special new organization is called for to raise and distribute funds for minority students in engineering programs. Mechanisms are described for channeling financial aid to students in ways which supplement but do not supplant existing sources of aid and which allow maximum freedom of choice and access to desirable institutions. Attention is also given to means of salvaging some of those minority youth who "fall between the cracks" in the present educational delivery system; the military services, federal programs, professional societies and community organizations, and ethnically controlled alternative schools are surveyed as potentially useful mechanisms to channel some of this large manpower pool into engineering programs.

Chapter 6, "The Price Tag for Progress," discusses the financial requirements as well as the possible sources of financial support for the additional minority engineering students called for throughout the report. Based on both conservative and optimistic projections of minority engineering enrollments from Chapter 4, and the most refined data available from the college financial aid community, the total cost of the national effort which must be carried out is calculated. For convenience, Table 1-2, which shows the year-by-year and the total funding requirements for both the college and precollege portions of the program (based upon conservative and optimistic enrollment projections), is reproduced here from Tables 6-18A and B. Table 1-2 reveals that even after parental contributions, federal assistance, student self-help, institutional financial-aid programs, and state and philanthropic assistance projected at current levels, there remains an unmet need of from $149 million to $215 million in new funds over the next nine years, depending upon whether the conservative or optimistic enrollment projections of Chapter 4 are attained. Most of this amount—from $117 million to $171 million—will be required for college-level programs of student financial aid and support services, with the remainder earmarked for precollege programs. Assuming that agencies and organizations now contributing to minority engineering programs continue to do so at the current levels of funding, and that the minority students and private colleges contribute heavily through loans, part-time employment and institutional scholarship funds, it will still be necessary to generate a total amount of from $68 million to $106 million in new college scholarship funds to educate the additional minority engineering students.

Appendix A, Members of the Planning Commission, lists the members of the Task Force along with their professional responsibilities and affiliations.

Appendix B, A Survey of Minority Engineering Programs, presents the results of an informal Task Force survey of 35 institutions which are currently operating programs to increase minorities in engineering.

THE TASK FORCE'S RECOMMENDATIONS

Any program to increase the participation of minority members in the profession of engineering must begin with engineering education. Furthermore,

TABLE 1-2

Total New Funds Required for National Program (Millions)

(After parental contributions, federal assistance, student self-help, institutional financial aid programs and state and philanthropic assistance)

YEAR	SUMMER TUTORIALS	COUNSELING-TUTORING	NET STUDENT FINANCIAL AID	FINANCIAL AID MANAGEMENT	SUB-TOTAL* COLLEGE LEVEL COSTS	RECRUITING ETC.	EARLY AGE RECRUITMENT	FUND RAISING	TOTAL
Conservative Projection									
1974-75	$ 1.560	$ .771	$ .971	$ .049	$ 3.351	$1.140	$ 1.180	$ .300	$ 5.971
1975-76	1.968	.964	2.021	.101	5.054	1.140	1.640	.600	8.434
1976-77	2.448	1.205	3.577	.179	7.409	1.000	2.060	.600	11.069
1977-78	2.976	1.477	5.440	.272	10.165	.800	2.300	.600	13.865
1978-79	3.528	1.767	7.502	.375	13.172	.700	2.500	.600	16.972
1979-80	4.032	2.048	9.773	.489	16.342	.600	2.623	.600	20.165
1980-81	4.320	2.250	11.633	.582	18.785	.500	2.623	.600	22.508
1981-82	4.560	2.390	13.197	.660	20.807	.400	2.623	.600	24.430
1982-83	4.707	2.490	14.322	.716	22.235	.200	2.623	.600	25.658
	$30.099	$15.362	$68.436	$3.423	$117.320	$6.480	$20.172	$5.100	$149.072
Optimistic Projection									
1974-75	$ 1.560	$ .771	$ .971	$ .049	$ 3.351	$1.140	$ 1.900	$ .300	$ 6.691
1975-76	2.088	1.001	2.263	.113	5.465	1.140	2.700	.600	9.905
1976-77	2.880	1.367	4.594	.230	9.071	1.000	3.340	.600	14.011
1977-78	3.840	1.844	7.768	.388	13.840	.800	3.700	.600	18.940
1978-79	4.800	2.358	11.540	.577	19.275	.700	3.940	.600	24.515
1979-80	5.568	2.813	15.517	.776	24.674	.600	4.200	.600	30.074
1980-81	6.000	3.119	18.808	.940	28.867	.500	4.200	.600	34.167
1981-82	6.288	3.306	21.369	1.068	32.031	.400	4.200	.600	37.231
1982-83	6.480	3.430	23.161	1.158	34.229	.200	4.200	.600	39.229
	$39.504	$20.009	$105.991	$5.299	$171.803	$6.480	$32.380	$5.100	$214.763

*The sum of the first four columns.

it will require a long-term effort at both the college and precollege levels. Accordingly, the recommendations which follow are divided into college and precollege categories which we present in two subsections: At the College Level, and At the Precollege Level. While the recommendations for action at the college level will probably produce the most immediate results, the permanent success of the effort, measured by the sustained output of minority graduates in engineering over a period of decades, can only be achieved with full implementation of those recommendations for precollege education as well.

The major findings of the Task Force which relate to the recommendations are summarized and follow each recommendation. (Detailed discussions of the findings appear in succeeding chapters and are cross referenced in the summaries.)

AT THE COLLEGE LEVEL

Recommendation 1:

The Task Force recommends that U. S. schools of engineering increase the percentages of Black American, Chicano, Puerto Rican, and American Indian students enrolled as freshmen, with the national goal of achieving approximate population parity in the freshman class by 1982, and in all classes by 1987.

Parity is defined for the four minorities taken together as 18%, for they will make up about 18% of the college-age population in the 1980's. The Task Force believes that the pattern of growth shown in Table 1-3 is a realistic one (an explanation of how the percentages were arrived at will be found in Chapter 4):

Recommendation 2:

The Task Force recommends the establishment of a single national organization to raise and distribute essential new funds for financial aid to minority engineering college students.

The Task Force believes that the single most important barrier today to increasing minority participation in engineering is the lack of adequate financial aid for minority college students. If we could provide an adequate scholarship for, and enroll in an engineering college, every one of the available well-prepared, college-bound minority youth who presently wishes to major in engineering, we would *double* our present minority freshman enrollment and would, with that one step, pass the half-way point of our parity goals in Recommendation 1. (covered fully in Chapter 4)

Several corporations and organizations are presently supporting minority engineering programs and many others have expressed an increased willingness to contribute to scholarship funds (see Reference 40 of Chapter 3). These programs and contributions have made possible the current levels of minority

TABLE 1-3

Proposed Growth of Minority Enrollment in Freshman Classes of U. S. Engineering Schools

YEAR	LEVEL OF MINORITY ENROLLMENT IN FRESHMAN CLASS	NUMBER* OF MINORITY FRESHMEN INVOLVED	INCREASE IN PERCENTAGE OVER PREVIOUS YEAR
(1)	(2)	(3)	(4)
1973–74	5 %	2,640	1%
1974–75	6 %	3,250	1%
1975–76	8 %	4,100– 4,350	2%
1976–77	10 %	5,100– 6,000	2%
1977–78	12 %	6,200– 8,000	2%
1978–79	14 %	7,350–10,000	2%
1979–80	16 %	8,400–11,600	2%
1980–81	17 %	9,000–12,500	1%
1981–82	17.5%	9,500–13,100	0.5%
1982–83	18 %	9,800–13,500	0.5%

*Depending upon whether engineering college enrollments follow the conservative or the optimistic projections in Chapter 4.

enrollments in engineering (5% of the freshman class) and must be continued if we are to maintain even these inadequate levels. If we intend to increase the production of minority engineers above the current levels, greatly increased funding will be required.

After taking into account parental contributions and federal scholarship programs, the additional minority engineering students called for will have college financial aid *needs* of from $151 million to $221 million (Tables 6-11) over the next nine years, depending upon whether engineering college enrollments follow the conservative or the optimistic projections of Chapter 4. Assuming that through a mixture of loans and part-time employment, the minority students themselves can reduce this need by between $25 million and $34 million, and that private universities will contribute scholarship funds between $41 million to $61 million, these two sources are expected to play the major role in reducing the unmet need for new scholarship aid to somewhere between $68 million and $106 million. The need for new funds will increase from less than a million dollars a year in 1974–75 to over two million in 1975–76, and will reach a peak somewhere between $14 million to $23 million per year by 1982–83. This will require that an additional average annual amount of between $7.60 million and $11.78 million in new scholarship aid, above and beyond current levels of funding by schools and concerned groups, must be raised over the next nine.

years if the increased enrollment goals of Recommendation 1 are to be achieved (see Chapters 5 and 6, especially Tables 6-18 A & B).

While the amounts of required new funds are large, they are far less than the amounts presently being raised by many universities. For example, the current three and a half year capital gifts campaign of Yale University has targeted $370 million for that single institution, requiring that an average amount of $106 million per year be raised from private sources. In addition, there are at least ten individual universities that raised over $27 million each from the private sector during the year 1973–74. It has been the experience of these successful fund-raising institutions that for programs of that magnitude it is necessary to mount a focused, centralized campaign.

Recommendation 3:

The Task Force recommends that financial-aid programs for engineering students be planned to cover five years of undergraduate study.

Since the Task Force found that instead of the usual four years of college required for other majors, it has been taking the average engineering student—majority as well as minority—closer to five years than to four in order to earn a B.S. degree in engineering (Chapter 3 and Appendix B), this fact should be acknowledged in the disbursement of financial aid funds. The Task Force applauds current efforts by engineering colleges to reduce the degree completion times of their matriculants to levels comparable to many liberal arts curricula.

Recommendation 4:

The Task Force recommends that corporations, foundations, and other organizations wishing to support engineering education for minorities give part of their scholarship contributions through the new fund-raising organization called for in Recommendation 2. Organizations still desiring to make contributions directly to certain educational institutions or individual students should continue to do so but should commit some additional resources to the national scholarship effort.

Recommendation 5:

The Task Force recommends that foundation support be provided to defray administration and operating costs of the new fund-raising organization for the first five years of its operation. Such support would offset overhead and high start-up costs and assure donors that a maximum share of money contributed would be utilized for direct assistance to students.

There is an understandable anxiety among some colleges and their current sources of corporate support for minority programs that a centralized national fund-raising effort may endanger their present funding relationships and jeopardize their local programs. Many educators fear the prospect of potential industrial supporters being able to say "I already gave to the *official* program" and neglecting to support local individuals or programs. Many potential

contributors want very much to maintain their present successful funding relationships and fear that a national program may channel additional resources or students away from the programs they have supported or "seeded." There is a genuine apprehension among some leaders of successful programs that they may find themselves less able to approach corporations and foundations directly in the future but, instead, may have to stand in line and submit requests to some centralized funding office which has siphoned off their individualized support.

The Task Force is sympathetic to these concerns and shares the conviction of those expressing them that the present levels of funding must be maintained and that successful programs must not be made to suffer by merely redirecting current financial support away from them and into a centralized agency. As a matter of fact, the Task Force is convinced that local, individually-tailored programs are essential components of any solution to the national problem and that, in the age-old tradition of excellence, concerned parties should continue to support quality programs in their own localities and spheres of influence.

It must be emphasized, however, that the current levels of financial support for existing minority programs are only sustaining the current inadequate minority enrollments in engineering. If we wish to increase the production of minority engineers to the equitable levels called for in Recommendation 1, greatly increased levels of funding must be provided by the corporations, government and other employers of engineers who stand to benefit most from the development of this vitally needed new source of technical manpower. Without diminishing the current levels of support, there is a need for a well-managed, low-overhead, intensive national effort to develop the necessary new sources of student scholarship aid and to distribute this aid in a manner which strengthens existing successful programs and encourages the development of new ones.

The new fund-raising organization we have called for should be free-standing enough to be tax-exempt and to operate under its own charter. We would expect it to draw heavily for its board of directors from the membership of the existing National Advisory Council on Minorities in Engineering (NACME), which represents the highest echelons of minority organizations, industry, professional societies, government, and education. The staff should include tested professional fund-raisers, able to deal with industries and other potential funding sources at high management levels, and with educational institutions at the same levels. In addition, the staff should include knowledgeable college financial aid experts capable of establishing fund delivery mechanisms and data and accounting systems. All efforts should be made to minimize overhead in order to maximize the educational productivity of funds secured. Arrangements with educational institutions should assure that funds disbursed shall supplement rather than replace existing resources, in order to increase minority enrollment beyond present levels.

It is suggested that the new organization be named the National Engineering Scholarship Fund (NESF). Funds raised by NESF should be earmarked for the specific purpose of providing direct scholarship aid to students, based primarily on need, and channeled through the engineering colleges where they are enrolled. In addition, NESF may award companion per-capita grants in

small amounts to the institutions chosen by students as an incentive for the institutions to provide tutoring, counseling, and other supportive services for an increasing number of minority students. (Further suggestions for the distribution of financial aid and the operation of NESF are described in Chapter 5.)

Recommendation 6:

The Task Force recommends that the National Academy of Engineering (NAE) assume a leadership role in coordinating the efforts of the many organizations working to increase minorities in engineering and in stimulating development of new programs that may be needed nationally. Without surrendering their independent prerogatives, these interested organizations should participate in the coordination effort and cooperate fully with each other, discussing their current activities and future plans so that other participants can factor these actions into their own plans and carry out a cohesive national effort.

Numerous engineering, educational, ethnic, governmental, business, and community organizations are already conducting programs to enable more minority students to enter and complete engineering programs (Chapter 5). Their efforts could be made more effective with responsible coordination of efforts and pooling of information. Many of the leading organizations interested in minority engineers are already represented on the Committee on Minorities in Engineering of the National Academy of Engineering. The Academy represents all segments of the engineering profession, has assembled a staff of five full-time people dedicated to minority engineering programs and appears to be the one organization presently staffed and properly constituted to provide this coordination.

Recommendation 7:

The Task Force recommends that some existing or specially created organization undertake to match and place qualified minority applicants with engineering schools seeking minority students.

At present there is no organization serving as an engineering admissions clearing house which specifically matches qualified minority high school graduates with engineering schools seeking minority applicants. In order to assure that every qualified and interested applicant is actually admitted in a suitable engineering program, such a clearing-house should be established.

Two existing organizations might expand their activities in a natural way to provide such a service. One of them, the Minority Engineering Education Effort (ME^3), compiles lists of potential students and interested engineering colleges, but does not involve itself with the actual admissions or follow-through required to be sure that a student gets admitted to some school. The other, National Scholarship Service and Fund for Negro Students (NSSFNS), does actively follow through and places students in colleges, but has no special ties with engineering and serves primarily Black students. In addition, the two national

testing agencies, American College Testing (ACT) and the College Entrance Examination Board (CEEB), have routine communications channels to all secondary schools and reach most college-bound youths. Another agency, the National Executive Committee on Guidance (NECG), the engineering profession's nationwide coordinated guidance program, has no special emphasis on minorities but assists students of all races to enter engineering colleges (Chapter 5).

Recommendation 8:

The Task Force recommends that the six traditionally Black universities with engineering programs be supported at optimum levels to insure that these programs achieve maximum minority enrollment during the next five years. An increase of 100% in their present enrollment is a realistic goal to be achieved in this time.

Over the last five academic years the six traditionally Black universities with engineering schools (Howard, North Carolina A & T, Prairie View A & M, Southern, Tennessee State, and Tuskegee) have produced nearly half of the Black engineering graduates in the U. S. (Chapter 3). These schools are presently operating at only about half of their current capacities. They are more flexible in their admissions and in providing compensatory and supporting services than are predominantly white schools. The six Black schools all offer ECPD accredited programs, and they achieve significantly higher retention rates for their students than do engineering colleges in general (see Appendix B). In 1973–74, with only marginal extra support, the six Black engineering schools were able to increase their freshman enrollments by 20%. These colleges represent a unique resource which should be developed further.

Recommendation 9:

The Task Force recommends that programs be developed with a selected number of colleges which have heavy concentrations of Chicanos, Puerto Ricans, and American Indians to provide pathways into engineering for these minorities as the Black colleges have traditionally provided for Black youth.

While there are several colleges in the country which have heavy concentrations of Chicano, Puerto Rican, and American Indian students, these institutions are generally two-year or community colleges without engineering programs and do not provide the effective pathway into engineering for non-Black minorities which the six Black schools provide for Blacks (Chapter 2).

Such programs will necessarily involve colleges such as Los Hostos in New York; Texas Southmost, El Paso Community College, several of the New Mexico and Arizona Universities; member institutions of the American Indian Higher Education consortium; El Congreso Nacional de Asuntos Colegiales, a council of the American Association of Community and Junior Colleges (AACJC); and colleges offering engineering degrees. They might also involve the American Society for Engineering Education (ASEE) and the National Executive Commit-

tee on Guidance (NECG), the engineering profession's coordinated guidance program (Chapter 5). Potential supporters and engineering colleges cooperating with ethnically dominated institutions will have to maintain a sensitivity to their desire to control their own destinies and to their concern about being relegated to "junior partner" roles.

Recommendation 10:

The Task Force urges support for efforts by engineering colleges to improve the articulation between engineering education and other institutions of higher education (two-year colleges and four-year institutions without engineering programs) in order to smooth the transition into engineering and to retain more transfer students in engineering.

The few Chicanos and American Indians who are attending college are overwhelmingly enrolling in inexpensive two-year community colleges, as are nearly half of the Puerto Ricans and Blacks. More than half of all college freshmen who intend to become engineers enter two-year colleges or four-year institutions with no engineering school. Such students have slightly lower retention rates in college than those who enroll as freshmen in engineering schools. The establishment of effective articulation agreements and mechanisms, such as California's Engineering Liaison Committee, between engineering colleges and community colleges, can produce dramatic improvements. Since such a large share of engineering students start out in nonengineering schools and, since so many minority students must start out in these schools, effective articulation will be necessary to draw and retain minority transfer students into engineering colleges (Chapter 3).

Recommendation 11:

The Task Force recommends that all schools of engineering provide remedial and tutorial programs, improved orientation and counseling, flexible curricula and, wherever possible, cooperative engineering programs with engineering employers. These should not be looked upon as merely "affirmative action" programs for minorities but should be recognized as essential for large numbers of students, whatever their racial or ethnic background.

Attrition among engineering students of all races is relatively high. From one-third to more than one-half may be lost to engineering between the freshman and senior years of college. Remedial and tutorial programs, better orientation and counseling, more flexible curriculum requirements, and participation in cooperative education programs which provide students with early exposure to the real world of engineering, can all reduce this attrition. Minority students have higher attrition rates in college than do white students. Even the seemingly well-prepared college-bound minority youth feel insecure about their preparation in mathematics and science and expect to have difficulty with these subjects in college. The additional numbers of minority youth we hope to attract

into engineering programs will find such supportive mechanisms invaluable (Chapters 2 and 3).

Recommendation 12:

The Task Force recommends that U. S. engineering schools develop programs to increase the output of Ph.D.'s from minority groups so that minorities will be adequately represented among faculty and administration leaders and will also serve as role models for engineering students.

In 1973 only one American Indian, 11 Spanish-surnamed, and 13 Black graduate students were awarded Ph.D. degrees by U. S. engineering schools, and there were probably very few Chicanos or Puerto Ricans among the 11 Spanish surnames reported (Chapter 4).

Even though there may be less demand for engineering Ph.D.'s because of the enrollment decline in engineering schools, there is still a dramatic need for minority Ph.D.'s to teach and serve as role models for minority students.

Since graduate education is so costly compared to undergraduate education the Task Force has focused its primary recommendations at the undergraduate level to accommodate a maximum number of students at economically feasible levels. The high cost of graduate education and the recent cutbacks in federal graduate student fellowships have caused the graduate engineering colleges to become less willing to "take chances" and allocate much of their reduced fellowship funds to minority students. Because our program to increase minority bachelors degrees expects the minority undergraduates to provide substantial amounts of self-help through loans and part-time work, and since these students are economically disadvantaged to begin with, they may finish college saddled with debts of $2,000 or more (Chapter 6). The economic pressures on them to take a job and not go on to graduate school may be overwhelming. It is not likely that many will find it attractive or even possible to take out another loan for graduate education.

On the other hand, graduate departments are more likely to admit and take a special interest in minority students who have their own financial awards (similar to those from industrial employers, the armed forces, the National Science Foundation, NASA, and the Ford Foundation). Unless the graduate schools themselves and organizations, such as those just mentioned, who are convinced of the value of graduate education commit equitable amounts of their resources to minority graduate students in engineering, we will not be preparing these students for leadership roles in advanced research and development or in academic and administrative positions.

Recommendation 13:

The Task Force recommends that programs be implemented to capitalize upon educational opportunities in the armed forces in order to channel more minority military personnel and veterans into engineering.

The armed services have traditionally enlisted a large percentage of minority youth, and today offer extensive college level (as well as college preparatory) opportunities for education. In 1972–73 more than 300,000 men and women in uniform took college work with federal assistance, not counting those receiving veterans' benefits. Another category of students affiliated with the military services includes those enrolled in dependents' high schools. Taken together, the service students form a sizeable pool of potential minority engineering students. The logical agencies to coordinate service education with engineering are the American Society for Engineering Education (ASEE), which represents engineering colleges and technical schools, and the National Executive Committee on Guidance (NECG), the engineering profession's coordinated guidance program (Chapter 5).

Recommendation 14:

The Task Force recommends that federal Special Services programs, now supported by the U. S. Office of Education (USOE) for providing tutorial and support assistance for disadvantaged college students, be maintained; and that engineering institutions and organizations explore with the USOE the feasibility of setting up jointly supported and operated pilot programs for engineering students.

The U. S. Office of Education supports three special programs for the disadvantaged intended to widen the availability of postsecondary education. Two of these, Upward Bound and Talent Search, are directed at precollege students but one of them, Special Services, provides tutorial and support assistance for students in or admitted to college (Chapter 5).

Recommendation 15:

The Task Force recommends that a number of honorific scholarships of, say $1,000 each be awarded to the top finalists and semifinalists in competitions run by the National Achievement Scholarship Program and the Upper Division Scholarship Competition for minority students—such awards to be used in an engineering educational institution. To provide greater access to higher education for other minority groups, the National Achievement Scholarship Program should be encouraged to expand its programs to include Chicanos, Puerto Ricans, and American Indians, as well as Blacks.

While the greatest portion of the engineering scholarship funds raised for minority engineering students should be allocated primarily on the basis of need, there is potentially great value in making some awards solely on the basis of merit or achievement. Attracting into engineering a few winners from the two competitions named above will do much to promote greater interest in engineering (Chapter 5). These finalists and semifinalists, because of their high visibility in their schools and communities, would not only serve as role models for the students a year or two behind them, but would also be critically important in engineering programs as living proof that not *all* minority engineering students

are educationally handicapped. They would also be extremely valuable resources for the tutoring and supportive programs called for in Recommendation 11.

Because it is of such value to demonstrate that outstanding minority high school and junior college students choose to pursue careers in engineering, these high-prestige engineering scholarships might profitably be coordinated with the "matching" organization called for in Recommendation 7 to make sure that each of the eligible students is actually placed in an engineering program of his or her choice.

AT THE PRECOLLEGE LEVEL

The Task Force finds that the goal of 18% representation for minorities in engineering cannot be met unless greater numbers of minority students receive adequate college preparation in high school (Chapter 2). It goes without saying that this Task Force enthusiastically supports the efforts of minority organizations and other concerned parties to see that equitable proportions of all ethnic and racial groups are prepared for and enter college. Many of our recommendations depend upon their success.

Recommendation 16:

The Task Force urges that programs be initiated to train greater numbers of elementary and high school teachers in bilingual and bicultural education. Particularly needed are minority science and mathematics teachers who can teach within their students' cultural experience and who can serve as role models for minority children.

All four of the underrepresented minorities, and especially the Mexican Americans, Puerto Ricans, and American Indians, are so poorly served by the nation's elementary and high schools that it is beyond the scope of engineering alone to deal comprehensively with the problems involved.

The Task Force sees two problem areas that deserve special attention. First, a major defect in the precollege education of Mexican American, Puerto Rican, and American Indian youth is the serious shortage at all grade levels of teachers trained to teach bilingual students, especially in science and mathematics. Without teachers who are trained in the languages and cultures which these students understand, it is unlikely that they will be able to perform up to their potentials (Chapter 2). Second and equally important for each of the minority groups is the critical lack of minority role models in their science and mathematics classrooms (Chapter 3). Even though there may be a general oversupply of education majors and a lack of demand for elementary and high school teachers, there is a drastic shortage of and a dramatic need for more minority teachers.

Such programs might well be initiated and sponsored by the U. S. Office of Education, the National Science Foundation, the National Institutes of Health, and other agencies interested in enlarging the pool of minority youth able to

pursue careers in medicine and other health fields as well as in science or engineering.

Recommendation 17:

The Task Force recommends the continuation of summer training programs for high school students and particularly urges that new programs be developed to attract minority students to engineering.

Recommendation 18:

The Task Force recommends strengthening present school-year programs and developing new efforts to interest minority high school and elementary school students in engineering, and to motivate them toward securing the necessary high school preparation for college.

The precollege programs recommended so far would increase the pool of minority students who might be qualified for and interested in entering engineering. In addition, a substantial proportion of the 18% goal recommended by the Task Force could be reached if minority students who are already college-bound could be redirected and motivated to take engineering in the same proportion that white students presently do (Chapters 3 and 4). While Blacks are increasingly college-bound, they are not entering engineering in the same proportion as whites or as Chicanos, Puerto Ricans and American Indians. Puerto Rican, Mexican American, and American Indian women are woefully underrepresented in the college-bound pool as well as in engineering programs. Black women, who are better represented in the college-bound group than are Black men and who are attracted by professional careers, are virtually unrepresented in engineering and constitute an obvious pool of potential engineers. Moreover, Black high school students who are interested in engineering frequently drift into other technical fields during college. Critical decision points in high school occur as early as the ninth grade when students must decide whether to follow an academic or a vocational curriculum, how much mathematics and natural science to schedule and what type of career to pursue. There is little understanding among high school students, teachers or counselors concerning the practical, real-world applications engineers make of mathematics and science and even those students planning on engineering careers are often misinformed about the educational requirements of such a career (Chapter 3).

Precollege summer programs can build the interest of high school students in engineering, as demonstrated by the National Science Foundation Summer Science Training Program, the summer programs of the Junior Engineering Technical Society (JETS), and the MITE program of the Engineer's Council for Professional Development (ECPD). Students' understanding of the profession can also be increased by participation during the school year in JETS or similar school-year engineering clubs such as MESA at the Lawrence Hall of Science and the University of California at Berkeley (Chapter 5).

The activities of ME^3 to increase minority interest in engineering and the

long-standing efforts of ECPD, JETS, and the newly created National Executive Committee on Guidance (NECG) to interest all college-bound youth in the engineering profession, as well as the capabilities of NSSFNS and National Achievement, should be effectively utilized in implementing Recommendations 17 and 18. The level of interest in engineering among college-bound minority youth could perhaps be monitored by observing the ACE freshman surveys each fall and tabulating the response of the four minority groups to the questions labeled "probable field of study," or "probable future occupation." The degree of interest among high school students could be estimated from expanded versions of such surveys as those carried out in the past by NSSFNS; from similar questionnaire responses on the national standardized tests administered by American College Testing Service (ACT) and the College Entrance Examination Board (CEEB); and as early as the junior year of high school from the Preliminary Scholastic Aptitude Test (PSAT) administered by the College Board.

Recommendation 19:

The Task Force recommends establishing programs to educate minority parents, science and mathematics teachers, and high school counselors concerning the opportunities in engineering, utilizing a field staff to reach minority community organizations, teachers, and counselors, and providing promotional material directed at the four underrepresented minority families and social structures.

Relatives and friends influence over 40% of engineers in their career choice. High school teachers and counselors, as well as high school course work itself, influence an additional 28% to choose engineering as a career (Chapter 3).

Recommendation 20:

The Task Force recommends expansion of the U. S. Office of Education's project, Talent Search, to identify and assist potential engineering students from the seventh grade on. In addition, the Task Force recommends the dedication of several pilot Upward Bound programs and experimental minority high school curricula to pre-engineering and science, perhaps in cooperation with engineering employers, as well as engineering colleges, to see if early career orientation will increase the desire of minority youth to acquire the skills necessary for success in college.

The U. S. Office of Education's Programs for the Disadvantaged include Upward Bound and Talent Search, which help to identify and prepare disadvantaged students for postsecondary education. In addition, there are serveral minority communities which have organized community-controlled alternatives to public schools and which are interested in developing specialized, profession-oriented curricula to motivate disadvantaged youth to acquire educational skills (Chapter 5).

2

The Progress of Minorities through the Educational System

To increase minority participation in engineering, it is first necessary to have some understanding of how the different minorities are progressing through the entire educational system. In this chapter we survey each of the four underrepresented minorities and attempt to pinpoint the special educational obstacles and needs of each group. The different groups are different, want to be recognized as different and, in many cases, must be dealt with differently. The brief overview provided in this chapter reveals that the number of Blacks going to college has grown so there is a reasonable college-bound pool each year, but that the college-bound Blacks are not participating equitably in engineering and related fields. Chicanos, Puerto Ricans, and American Indians, on the other hand, are not finishing high school, entering college or finishing college in anything even approaching representative numbers.

THE EDUCATION OF BLACK AMERICANS

Blacks, Negroes, or Afro-Americans—the largest and most widely studied social minority in the United States—have been virtually excluded from all levels of formal education for the greater part of our nation's history. In this section we shall highlight some of the problems of Black education which relate to the underrepresentation of Blacks in engineering.

High School—Falling Behind, Dropping Out, and Other Factors

Elementary and secondary education for Blacks is plagued with many of the same problems we will describe among the other minorities. Black students take

longer to complete school than whites, have a higher dropout rate, and accordingly produce a lower percentage of high school graduates.

For example, census data show that a Black American male 17 years old is three times more likely than a white male the same age to be two years or more behind the modal grade (the senior year of high school for a 17-year-old). In 1971, only about 40% of Black 17-year-olds were high school seniors, but among whites more than two-thirds of the boys (66.8%) and more than three-fourths of the girls (76.5%) were seniors.[1]

The high school dropout rate among Blacks is declining but is still considerably higher than that of the white population. For instance, Table 2-1 shows the percentage of dropouts in the 14-24 age bracket for the years 1967 and 1972.

TABLE 2-1

High School Dropout Rates Among Blacks and Whites 14-24 Years Old, 1967 and 1972

Year	Males		Females	
	BLACKS	WHITES	BLACKS	WHITES
(1)	(2)	(3)	(4)	(5)
1967	23.9%	11.6%	21.8%	13.1%
1972	17.8%	10.7%	17.2%	11.9%

SOURCE: *The Social and Economic Status of the Black Population in the United States*, 1972 (Washington, D.C.: U.S. Department of Commerce, Bureau of the Census, Current Population Reports, Series P-23, No. 46, July 1973), p. 63, Table 49.

Table 2-1 shows that among Black males, 23.9% had dropped out in 1967 but only 17.8% had in 1972. However, the latter rate was still considerably higher than that for white males in 1972 (10.7%). Black females reduced their dropout rate, too, but not as much.

Not unexpectedly, this leads to a smaller share of high school graduates among Blacks than whites. As Table 2-2 illustrates, the percentage of high school graduates in the Black population aged 20-29 has risen since 1960, but in 1972 was about 20% less than the percentage for whites of the same age and sex.

We can see from Table 2-2 that in 1972 approximately 65% of Black men and women 20 to 29 years old were high school graduates compared to about 83% of the whites. Things are getting better for Blacks, though. More of them are staying in school beyond the end of compulsory attendance (through age 15). In fact the percentage of Black 16- and 17-year-olds in school in 1972 was

TABLE 2-2

High School Graduates among Blacks and Whites 20-29 Years Old, 1960, 1967, 1970, and 1972

Year	Males		Females	
	BLACKS	WHITES	BLACKS	WHITES
(1)	(2)	(3)	(4)	(5)
1960	38%	64%	43%	66%
1967	52%	77%	56%	77%
1970	59%	81%	63%	80%
1972	64%	84%	66%	83%

SOURCE: *The Social and Economic Status of the Black Population in the United States*, 1972 (Washington, D.C.: U.S. Department of Commerce, Bureau of the Census, Current Population Reports, Series P-23, No. 46, July 1973), p. 64, Table 50.

greater than that for whites of the same age (90% for Blacks, 89% for whites). Among those aged 18 and 19 in 1972, 43% of Blacks and 47% of whites were in school.[2] Thus, the percentage of Blacks finishing high school is rising, although it is still well below that for whites.

Black Enrollment in College

When this Task Force began its study of minority education, there was a general impression in the country that Blacks had actually come close to equality with whites in the percentage of high school graduates who go on to college. To our great disappointment, we have found that this impression is false, and appears to have been based upon a widely reported interpretation of a single year's statistic derived by the Bureau of Labor Statistics.[3] In that single year, 1972, the percentage of white graduates going on to college suddenly dropped to only 49%, and a small increase in the Black percentage raised their level to 48%. Unfortunately, this innocent one year statistic came to be remembered by many to indicate that Blacks had caught up to whites. Table 2-3 shows the Bureau of Labor Statistics measures of college entry for Blacks and whites since 1962 and places the 1972 percentages in perspective.

The data in Table 2-3 show that the gap in college entry between Black and white high school graduates has become narrower but that it still is substantial. The disparity actually increased in 1973 to 13%, according to the Bureau of Labor Statistics, and it averaged 8.6% over the period from 1969 to 1973. While there is still much to be done before Blacks do attain parity with whites in this

TABLE 2-3

Proportion of High School Graduates Enrolled in College in October of the Year of Graduation, 1962-1973

YEAR	ALL PERSONS	WHITES	BLACKS AND OTHER RACES
(1)	(2)	(3)	(4)
1962	49%	51%	34%
1963	45%	46%	38%
1964	48%	49%	39%
1965	51%	52%	43%
1966	50%	52%	32%
1967	52%	53%	42%
1968	55%	57%	46%
1969	54%	55%	37%
1970	52%	52%	48%
1971	53%	54%	47%
1972	49%	49%	48%
1973	47%	48%	35%

SOURCE: "Employment of High School Graduates and Dropouts October 1972: 'The High School Class of 1972' " (Washington, D.C.: U. S. Department of Labor, Bureau of Labor Statistics, Special Labor Force Report 155, 1973), p. 29, Table 3, and "Employment of School Age Youth, October 1973" (Special Labor Force Summary, April 1974), p. 3.

respect, there is, nonetheless, a substantial pool of Black college-bound youth.

The growth of Blacks enrolling in college has been one of the most dramatic phenomena in American higher education. During the first 125 years after the nation's founding only 2,500 Blacks received college educations.[4] Since 1900, Black college enrollment has at least doubled with every passing decade until, today, about 18% of the Black college-age population—over half a million students—is attending college.[5] In Table 2-4 we can see how the college enrollments of Blacks have almost doubled since 1965, but that they still fall short of the white proportion of 26% enrollment of college-age youth.

In 1973, according to the American Council on Education (ACE), Blacks constituted 7.8% or 128,618 students out of the 1,648,856 full-time, first-time American college freshmen.[6] This number was slightly lower than the figure of 8.7%, or 135,503, Blacks out of the 1,557,512 total freshmen in 1972, and marks the first time in recent years that the college freshman enrollment of Blacks did not increase.[7] Since Blacks make up about 13% of the college-age population,[8] they still have some distance to go before achieving college enrollment parity.

In general then, enlarging the pool of Black students who would be interested in and qualified to enter engineering programs will require long-

TABLE 2-4

College Enrollment of Blacks and Whites 18-24 Years Old, 1965-1972

Year	Black		White	
	STUDENTS ENROLLED	PERCENTAGE OF 18-24-YEAR-OLD POPULATION	STUDENTS ENROLLED	PERCENTAGE OF 18-24-YEAR-OLD POPULATION
(1)	(2)	(3)	(4)	(5)
1965	210,000	10%	4,213,000	26%
1967	297,000	13%	4,710,000	27%
1971	522,000	18%	5,594,000	27%
1972	540,000	18%	5,624,000	26%

SOURCE: *The Social and Economic Status of the Black Population in the United States*, 1971 (Washington, D.C.: U.S. Department of Commerce, Bureau of the Census, Current Population Reports, Series P-23, No. 42, July 1972), p. 85, Table 67 (1965 and 1971) and the same publication for 1972 (Current Population Reports, Series P-23, No. 46, July 1973), p. 62, Table 48 (1967 and 1972).

range efforts aimed at both the college and precollege years. Those entering college will need to be attracted to engineering and retained in college in greater numbers. In addition, more of those in high school will need to receive satisfactory college preparation, and more will need to complete high school instead of dropping out. The situation for Blacks contrasts with that for the other minorities, particularly Chicanos and Puerto Ricans who, as we shall see, are not now attending college in sufficient numbers to form an available, sizeable pool of potential engineering students. The effort among Blacks, accordingly, will depend as much upon drawing Black college-bound students into engineering, and keeping them in college, as upon getting more Blacks to prepare for college in the first place. We will now examine the college picture in more detail since those Black students who are college-bound or already in college will represent the most immediate source of new engineering students.

College—Dropping Out, Two-Year Colleges, and Other Factors

Because large numbers of both Black and white high school graduates enter college, there is a substantial pool of potential engineering students each year. But the Black pool diminishes more rapidly than the white pool. For one thing, a greater share of Blacks drop out of college, so that a smaller proportion receives

TABLE 2-5

Persistence of Black and Non-Black Students in College, Class of 1970, Four Years After Admission

Student Category	Two-Year Colleges		Four-Year Colleges and Universities	
	BLACKS	NON-BLACKS	BLACKS	NON-BLACKS
(1)	(2)	(3)	(4)	(5)
Total Number of Students	30,769	504,484	51,761	950,619
Share Returned for Second Year	67.3%	66.2%	75.8%	78.1%
Share Received Degree (AA, BA, or BS)	29.4%	39.0%	42.1%	47.0%
Share Received Degree or Still Enrolled	30.4%	41.1%	56.2%	58.6%
Share Received Degree, Still Enrolled, or Requested Transcript Sent to Another Institution	56.9%	66.4%	73.0%	81.5%

SOURCE: A. A. Astin, *College Dropouts: A National Profile* (Washington, D.C.: American Council on Education, ACE Research Reports, Vol. 7, No. 1, February 1972), p. 15.

degrees. Table 2-5 shows the result of a study of 1970 college freshmen, in which four separate criteria were used to measure persistence in college one year and four years later.[9]

As illustrated by Table 2-5, Astin found that Blacks were less likely to continue in college than non-Black students, both in two-year and four-year institutions, no matter which persistence measure was examined. However, when compared with non-Black students of equal ability, Astin found that persistence rates for Blacks were at least as high as and probably higher than persistence rates for non-Blacks.

The major share of the growth of Black college enrollment has been taking

place in junior or community colleges until, today, more than two-fifths of the full-time and half of the total of Black freshmen are starting out in two-year institutions.[10]

Many Blacks are concerned about this changing pattern of college enrollment. They recognize that community colleges open important opportunities for many students, particularly those with limited financial resources. But Blacks are afraid that a large proportion of students will be deprived of the opportunity for high-caliber education, and therefore will have less chance to pursue professional careers or gain executive positions later in life. Part of the problem is that many colleges and universities are cutting back on their commitments to minority students, particularly for financial aid.[11] As the participants in a symposium on higher education for Blacks stated in 1972, community colleges are viewed by some as " 'dumping grounds' where the powerless will be made employable but not equipped or encouraged to pursue higher aspirations."[12]

The implications of this trend are clear for engineering education. Any program to attract significantly larger numbers of Blacks into engineering will have to work with substantial numbers of students enrolled in, or planning to attend, two-year colleges.

Before leaving the college scene it is also important to comment upon the changing picture in regard to the traditionally or predominantly Black colleges and universities. During most of the present century they offered Blacks practically the only opportunities they had for college education. As late as 1960 it has been estimated that these institutions accounted for about two-thirds of all Blacks enrolled in college.[13] They also trained the overwhelming majority of Black professionals.[14] But in the 1960's the greatest increases in Black enrollment began occurring in the predominantly non-Black institutions.[15]

The future of the predominantly Black colleges and universities is uncertain. Blacks are no longer as heavily concentrated in the Southern states as they once were,[16] but that is where most Black schools are located. Furthermore, most of these institutions face severe financial problems, compounded by the fact that they have never had adequate support, so that today's inflation is an even heavier burden upon them than upon most educational institutions. But the Black colleges and universities have played, and continue to play today, a vital role in higher education for Black Americans. Unfortunately, there is no comparable group of colleges and universities serving the needs of Chicanos, Puerto Ricans, or American Indians.

Finally, there is one other important difference between the four minorities. In contrast to Chicanos, Puerto Ricans, and American Indians, whose populations are concentrated in small geographic areas, Blacks are rather widely dispersed in the U. S. New York State had the largest number in the 1970 census and was the only state with more than 2 million Blacks. But eight other states and the District of Columbia had more than half a million each. The number of Blacks and the percentages they represent of the total U. S. Black population are given in Table 2-6, along with school enrollments, for the 19 states and the District of Columbia, which together have almost 90% of the country's Black citizens.

TABLE 2-6

States (and the District of Columbia) with the Largest Black Population and School Enrollment, 1970

State	Population		School Enrollment					
			ELEMENTARY		HIGH SCHOOL		COLLEGE	
	NUMBER	PERCENT*	NUMBER	PERCENT*	NUMBER	PERCENT*	NUMBER	PERCENT*
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
New York	2,164,560	9.6%	396,477	8.6%	153,356	8.6%	39,704	9.2%
Illinois	1,422,353	6.3%	299,032	6.4%	110,260	6.2%	30,361	7.0%
California	1,398,498	6.2%	271,719	5.9%	114,398	6.5%	46,719	10.8%
Texas	1,396,605	6.2%	281,290	6.1%	104,786	5.9%	25,720	6.0%
Georgia	1,184,062	5.3%	249,268	5.4%	93,395	5.3%	15,073	3.5%
North Carolina	1,125,885	5.0%	232,266	5.0%	97,894	5.5%	20,393	4.7%
Louisiana	1,085,227	4.8%	240,527	5.2%	86,535	4.9%	18,443	4.3%
Florida	1,041,966	4.6%	226,365	4.9%	83,768	4.7%	16,389	3.8%
Penn.	1,016,551	4.5%	199,227	4.3%	79,054	4.5%	15,303	3.6%
Michigan	990,663	4.4%	188,771	4.1%	82,072	4.6%	21,364	5.0%
Ohio	970,130	4.3%	193,198	4.2%	80,247	4.5%	16,828	3.9%
Alabama	903,000	4.0%	194,633	4.2%	77,434	4.4%	16,126	3.7%
Virginia	860,302	3.8%	177,645	3.8%	64,725	3.7%	14,003	3.3%
Mississippi	815,626	3.6%	194,082	4.2%	67,513	3.8%	12,754	3.0%
South Carolina	788,455	3.5%	177,859	3.9%	70,766	4.0%	8,091	1.9%
New Jersey	769,245	3.4%	154,969	3.4%	55,545	3.1%	12,145	2.8%

Maryland	698,494	3.0%	147,360	3.2%	51,302	2.9%	12,899	3.0%
Tennessee	620,636	2.8%	127,641	2.8%	50,641	2.9%	13,372	3.1%
District of Columbia	537,570	2.4%	99,633	2.2%	34,775	2.0%	15,507	3.6%
Missouri	479,746	2.1%	102,511	2.5%	34,813	2.0%	8,387	1.9%
Total of 19 States and D.C.	20,269,574	89.8%	4,154,573	90.0%	1,593,279	89.8%	379,581	88.1%
U.S. Total	22,549,815	100%	4,615,623	100%	1,772,979	100%	430,747	100%

*Percent of Total Blacks in U. S.

SOURCE: *Negro Population* (Washington, D.C.: U. S. Department of Commerce, Bureau of the Census, 1970 Census of Population, Special Report PC(2)-1B, May 1973), pp. 1 (col. 2) and 23-29 (cols. 4, 6, and 8).

THE EDUCATION OF MEXICAN AMERICANS

While Black students have drawn nearer to whites in at least one measure of educational attainment (in the share of high school graduates who get into colleges), Chicanos—or Mexican Americans—do not even do that. In fact, they are less likely to be successful in school than their Black classmates at every level of education—elementary school, high school, and college. In the five southwestern states, where almost 90% of Mexican Americans live, fewer than one-fourth of those who enter elementary school get to college, and fewer than one-fourth of the college freshmen earn a bachelor's degree within four years.[17] The message for engineering education is clear: Any effective program to recruit more Mexican American students into engineering will depend heavily upon other efforts to improve the opportunities and performance of Chicano students at all grade levels.

Many Chicanos are upset about the situation. As one of their leaders has said " . . . the Mexican American has a lower educational level than either Black or Anglo; the highest dropout rate; and the highest illiteracy rate. These truths stand as massive indictments against the present educational system. As well, they are indictments of either negligent or intended homicide against a minority group. In essence, what this system has done is to smother the soul and spirit of an entire people."[18]

The effects of poor education among Chicanos are visible in numerous statistical measures. For example Table 2-7 demonstrates clearly that at every age level Mexican Americans lag far behind the total U. S. population in the proportion that has completed four or more years of high school.

Among all those over 25 years of age, Chicanos are less than half as likely to have graduated from high school. And the 1970 census showed that the Spanish heritage population of the five southwestern states, which is predominantly Chicano, had completed from 1½ (in California) to nearly 5 fewer years of school (in Texas) on the average than the national median for all races (12.1 years).[19] Illiteracy in English is of course a problem among the Spanish-speaking Americans. A 1969 census bureau study found that 28% of Mexican Americans aged 25 or older said they could not read and write English, although only 5% of those 10-24 years old were illiterate.[20]

The educational progress of Chicanos is somewhat easier to evaluate than that of certain other minorities because Mexican Americans live primarily in one region of the U. S.—the five-state area covered by California, Arizona, New Mexico, Colorado, and Texas. Both 1970 and 1973 census data indicate that 86–87% of Chicanos are found here. We have used 1970 census data in Table 2-8 because a state-by-state breakdown was included.

These numbers are no longer current, however. In March of 1973 the census bureau counted Spanish Americans again, and in this study the number of Chicanos in the Southwest rose significantly. The total Mexican American population of the Southwest was given as 5,394,000. Nationally, the number of persons of Mexican origin was given as 6,293,000, a 38.8% increase from the

TABLE 2-7

Chicano High School Completion, by Age Group, 1972

Age Group	Percentage Completing Four Years of High School		
	TOTAL U.S. POPULATION	CHICANO	TOTAL SPANISH ORIGIN
(1)	(2)	(3)	(4)
25–29 years old	79.8%	42.9%	47.6%
30–34 years old	73.9%	40.1%	42.7%
35–44 years old	66.8%	28.0%	35.2%
45–54 years old	59.8%	14.2%	24.9%
55–64 years old	46.7%	8.8%	20.6%
65 years and older	32.0%	0.6%	12.1%
Total, 25 years and older	58.2%	25.8%	33.0%

NOTE: Col. 4, Total Spanish Origin, includes other persons of Spanish origin, not shown separately.

SOURCE: "Selected Characteristics of Persons and Families of Mexican, Puerto Rican, and Other Spanish Origin: March, 1972" (Washington, D.C.: U. S. Department of Commerce, Bureau of the Census, Current Population Reports, Series P-20, No. 238, July 1972), p. 5.

1970 census figures.[21] Table 2-9 shows the correction to the total lines of Table 2-8.

The 1973 recount was carried out because Spanish American leaders claimed that the 1970 census did not include a large number of persons of Spanish origin living in the U. S.[22]

The only state outside the Southwest with a Chicano population larger than 100,000 in 1970 was Illinois (160,419), so it is evident that any program to attract Chicanos to engineering, or to improve Chicano education generally, will have to be concentrated in the five southwestern states.

The low educational attainment of Chicanos in the Southwest is summarized in Table 2-10.

Chicanos are behind whites and Blacks in the median number of years of school completed, and in the share completing high school, one year of college, and four years of college. For instance, more than half of all persons aged 25 or over in the five southwestern states had finished four years of high school or more, but only about one-third of the Spanish Americans (Spanish Americans in this region being predominantly Chicanos). Three fourths of all those in the

TABLE 2-8

An Estimate of the Chicano Population in Five Southwestern States, 1970

STATE	CHICANO POPULATION	PERCENTAGE OF U.S. CHICANO POPULATION IN STATE OR REGION
(1)	(2)	(3)
California	1,857,267	41.0%
Texas	1,619,064	35.7%
Arizona	239,811	5.3%
New Mexico	119,049	2.6%
Colorado	103,584	2.3%
Five Southwestern States	3,938,775	86.9%
U.S. Total	4,532,435	100.0%

SOURCES: Col. 2 data were taken from *Persons of Spanish Origin* (Washington, D.C.: U. S. Department of Commerce, 1970 Census of Population, Subject Report PC(2)-1C), Table 3 pp. 8–9, 11, 13, 23, and 29. The population called "Chicano" here is called "Persons of Mexican Origin" in that publication. Col. 3 was calculated by dividing the state or five-state population in Col. 2 by the U. S. total at the bottom of Col. 2.

TABLE 2-9

A Recount of the Chicano Population, 1973

AREA	CHICANO POPULATION	PERCENTAGE OF U.S. CHICANO-POPULATION IN REGION
(1)	(2)	(3)
Five Southwestern States	5,394,000	86.0%
U. S. Total	6,293,000	100.0%

SOURCE: "Persons of Spanish Origin in the United States: March 1973" (U. S. Department of Commerce, Bureau of the Census, Current Population Reports, Series P-20, No. 264, May 1974), page 19, Table 1.

TABLE 2-10

Educational Attainment of Persons 25 and over, and 25 to 29, in Five Southwestern States, 1970

Ethnic Group	% Completing 4 Years of High School or More		% Completing At Least 1 Year of College		% Completing 4 Years of College or More		Median Years of School Completed	
	25 AND OVER	25-29	25 AND OVER	25-29	25 AND OVER	25-29	25 AND OVER	25-29
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
All races	57.7%	75.3%	27.3%	38.2%	12.7%	17.5%	12.3	12.7
White	59.1%	76.1%	28.2%	39.2%	13.2%	18.2%	12.3	12.7
Black	40.0%	65.8%	15.4%	23.8%	5.3%	6.6%	10.6	12.3
Spanish American (predominantly Chicano)	34.8%	51.9%	13.0%	18.8%	5.1%	6.3%	9.7	11.7

NOTE: "Spanish American" refers to persons of Spanish language or Spanish surname in Arizona, California, Colorado, New Mexico, and Texas. Of the 6,188,362 Spanish Americans identified in the source documents in 1970, 96.1% were white, 1.2% Negro (Black), and 2.7% of other races. Data for whites and Negroes include Spanish Americans.

SOURCE: Table comes from *Task Force Report on Higher Education in Chicanos, Puerto Ricans, and American Indians* (an unpublished report of the Federal Interagency Committee on Education's Task Force on Higher Education for Disadvantaged Minorities, April 1973), p. 43. It utilizes data from *Detailed Characteristics* (Washington, D.C.: U. S. Department of Commerce, Bureau of the Census, 1970 Census of Population Series PC(1)-D), State Report Nos. 4, 6, 7, 33, and 45, Table 148.

25–29 age bracket had that much education, compared to about 52% of the Spanish Americans. And only a small proportion of the Spanish Americans had completed college—about two-fifths of the share in the general population.

Younger Chicanos are better educated than their elders, which is illustrated in Table 2-10 by the differences between 25- to 29-year-olds in 1970 and all those over age 25. Furthermore, in the 18–24 age group 52% had graduated from high school, but 77% of the non-Spanish population of the same age in the Southwest were high school graduates.[23]

At the college level, Chicanos are only half as likely to attend college as non-Spanish persons. For example, only 13.7% of Spanish Americans aged 18–24 in the five southwestern states attended college in 1970 while 26.4% of all others in that age group were enrolled in college.[24]

The overall experience of Chicano students is suggested by Table 2-11 which shows what happened to one class as it progressed from first grade through college. This table was prepared from data of the U. S. Civil Rights Commission.

TABLE 2-11

School Retention Rates in Five Southwestern States

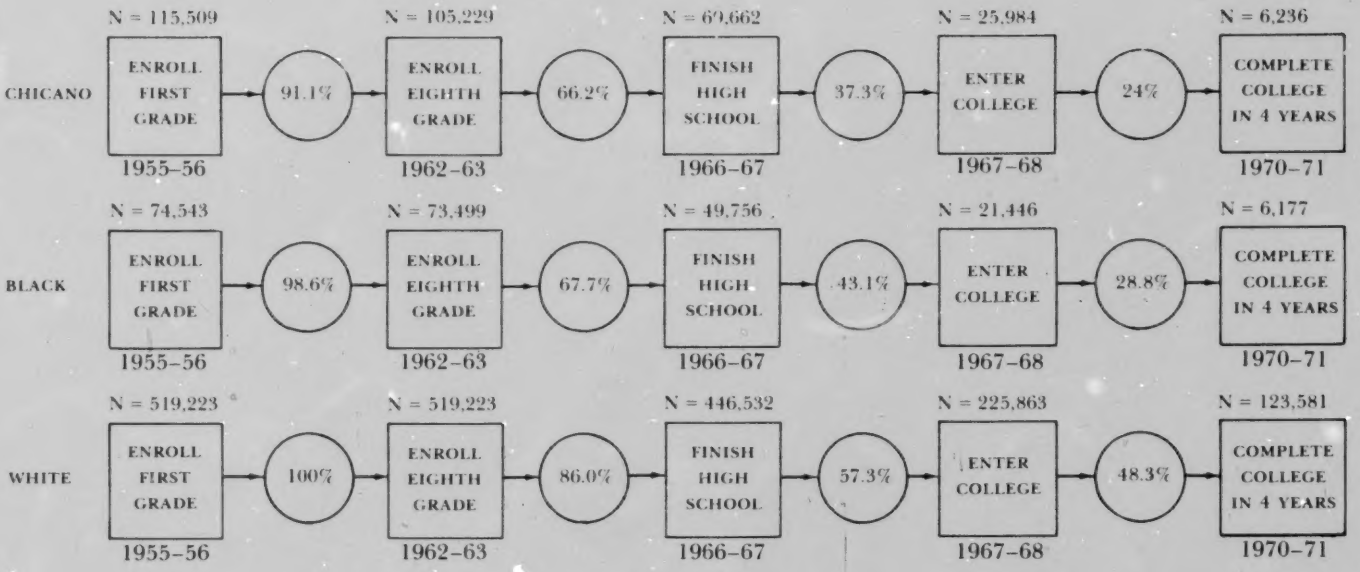
ETHNIC GROUP	GRADE 1	GRADE 8	GRADE 12	ENTER COLLEGE	COMPLETE COLLEGE WITHIN FOUR YEARS
(1)	(2)	(3)	(4)	(5)	(6)
Chicano	100.0%	91.1%	60.3%	22.5%	5.4%
Black	100.0%	98.6%	66.8%	28.8%	8.3%
White	100.0%	100.0%	86.0%	49.3%	23.8%

SOURCE: *The Unfinished Education: Outcomes for Minorities in the Five Southwestern States* (Washington, D.C.: U. S. Commission on Civil Rights, Mexican American Educational Series Report II, October 1971), p. 11. Figures represent the percentage of students remaining after seven months of the school year. It is estimated that less than 1% of those indicated for grade 12 would fail to graduate. Percentages were calculated from a spring 1969 Commission survey, modified with information from the Bureau of the Census and the U. S. Department of Health, Education, and Welfare.

The last table illustrates that out of every 100 Chicano children who enter first grade, one-third have dropped out by the end of the 12th grade, less than one-fourth enter college, and fewer than six graduate from college. By way of contrast, almost one-half of the whites enter college and nearly a quarter of the original 100 graduate. Thus it is clear that any program designed to draw more Chicanos into engineering, or just through college generally, will have to deal with precollege education down through the elementary grades as well as college itself. More Chicanos will have to be retained in elementary school and high school, and more will have to enter and complete college than presently do so.

FIGURE 2-1

Student Progress in Five Southwestern States, 1955-1971



NOTE: Numbers on top of boxes indicate the number of students enrolled in each grade, calculated from the source material below, and numbers in circles indicate the percentage of students completing the step from one box to the next.

SOURCES: Numbers of students were calculated using 1967–1968 figures for college freshmen from *The Unfinished Education: Outcomes for Minorities in the Five Southwestern States* (Washington, D.C.: U. S. Commission on Civil Rights, Mexican American Educational Series Report II, October 1971), p. 76 (Table 5, Col. 2). Retention rates from Table 2-11 were applied to these figures to calculate students at the grade levels shown.

The diagram in Fig. 2-1 utilizes the retention rates of Table 2-11 and Civil Rights Commission estimates of the college freshman enrollment in the Fall of 1967 to indicate where the attrition is occurring and what numbers of students are involved at each grade level.

Black and Anglo data are given for comparison. The number on top of each box in Fig. 2-1 indicates the number of students at the level represented by that box and the percentage given inside each circle shows what share of the number in the previous box reached the grade level represented by the next box. In other words, 91.1% of the 115,509 Chicano first graders in 1954 finished eighth grade in 1963, but only 66.2% of the 105,229 eighth graders completed high school in 1967. And of the 25,984 who entered college in the fall of 1967, only 6,236, or 24%, completed college within four years. If this educational experience were duplicated elsewhere in the United States, it would indicate that about 7,176 Chicanos graduated from college in 1971 on the basis of population porportions (6,236 = 86.9%, 7,176 = 100%). Whatever the actual number was in 1971, it should be larger today for two reasons. First, Chicano school-age and college-age populations have been growing (as will be seen in Table 4-10, Col. 4). Second, the proportion of students completing college should increase with the rising expectations and opportunities for Chicanos.

That then is a general summary of the overall statistics. But what causes lie behind such numbers? The major defects in Chicano education have been well documented by the U. S. Commission on Civil Rights, drawing principally from a survey of Mexican American education in the Southwest during the spring of 1969 and from a racial and ethnic education survey conducted by the U. S. Department of Health, Education, and Welfare in the fall of 1968.[25] The following subsections summarize many of the Commission's major findings.

Chicano Children Are Held Back

Practically as soon as Mexican American children enter first grade their difficulties begin. One measurable phenomenon is grade repetition, which occurs almost exclusively in elementary school. As the Commission showed, a Chicano in one of the five southwestern states is more than 2½ times as likely to repeat the first grade as an Anglo (white) child, and 1¾ times as likely as a Black. A Mexican American is about twice as likely to repeat fourth grade as his Anglo or Black schoolmates.[26]

One of the consequences of grade repetition is that Chicano students on the average are older than their Anglo or Black classmates. By eighth grade a Chicano child is almost eight times as likely as a white to be more than two years older than the average at that grade, and more than four times as likely as a Black.[27] This apparently contributes to dropping out from school, too. The Commission estimated that 41% of Mexican American eighth graders who were overage dropped out before completing high school.[28]

Ability Grouping Discriminates Against Chicanos

The Commission also reported that Chicanos (as well as Blacks) were overrepresented in the low categories where schools separated students into low, normal, and high ability groups. One-third of Chicano elementary and secondary students in the Southwest were in low ability groups at the time of the Commission's survey between October 1970 and February 1971, but only 14.6% of Anglos. The high ability groups contained 26.3% of the Anglos but only 13.9% of the Chicanos.[29] This would suggest that southwestern public schools were not preparing a representative proportion of Chicano students for college, much less for engineering.

Language is a Barrier

The overall Chicano educational picture is influenced by several social and ethnic factors which will also have to be considered in any long-range program for drawing this minority group toward the profession of engineering. Perhaps most critical is the language barrier. Some substantial proportion of all Mexican Americans is made up of fairly recent immigrants. The U. S. Department of Labor estimates that "probably less than half" are first- or second-generation residents.[30] But Spanish-speaking children are handicapped in school because of the shortage of Chicano and bilingual teachers in the Southwest. Out of the 325,000 teachers in the five-state region in 1972, only 4.8% were of Spanish surname, while Chicanos were 18% of the school-age population.[31] Those who teach Chicanos, whether they are Anglo or Chicano themselves, are poorly prepared for the task. This is evidenced by the shortage of Chicanos among education school faculty, of Chicano-oriented courses in education schools, and of opportunities for student teaching with Chicanos.[32] One author has suggested that this lack of special training among teachers is more critical than the actual underrepresentation of Chicanos on teaching staffs.[33] Similar problems exist among counselors and administrators.

Related to the language obstacle is the Commission's observation that, in the Southwest, at fourth, eighth, and twelfth grade levels the Chicano students were about twice as likely as Anglo children to read below grade level. By twelfth grade, for example, an estimated 62.6% of Mexican American students read at least one-half year below grade level, and 40.2% were two years or more below the proper grade. Among Anglos, though, only 33.7% were half a year below grade level and only 18.8% more than two years.[34]

To these difficulties are added forms of educational discrimination related to lack of English language skills. The Civil Rights Commission has cited school districts for excluding large numbers of Chicanos from effective participation in educational programs on the basis of language or culture and for assigning Chicanos to classes for the mentally retarded because of limited English.[35]

Despite these obstacles, illiteracy in English is rapidly declining. A 1969 census study showed that among Chicanos over the age of 25, 28% said they were unable to read and write English, but this was true for only 5% of Chicanos aged 10 to 24.[36] A higher proportion of Mexican Americans is also completing high school, which in part explains and in part is a result of the improved literacy.[37]

Too Few Graduate from College

Some of the characteristics of precollege education for Chicanos are repeated at the college level. Mexican Americans are underrepresented in Southwestern college enrollment, as illustrated in Table 2-12.

A high college dropout rate is confirmed by the low proportion completing college when compared to Anglos (24% vs. 48.3% of college freshmen, shown in Fig. 2-1).

The dropout rate may be explained in part by the fact that three-quarters of

TABLE 2-12

Proportional Representation of Ethnic Groups Among College Undergraduates in Five Southwestern States, 1970

ETHNIC GROUP	NUMBER OF FULL-TIME STUDENTS	PERCENTAGE OF ENROLLMENT	PERCENTAGE IN POPULATION OF SOUTHWEST
(1)	(2)	(3)	(4)
White	869,761	83.4%	72%
Mexican American	72,133	6.9%	15%
Black	59,372	5.7%	8%
Indian	10,489	1.0%	1%
Oriental	31,697	3.0%	1%
Total	1,042,372	100%	100%

SOURCE: Column 2 data came from *Racial and Ethnic Enrollment Data from Institutions of Higher Learning* (Washington, D.C., U. S. Department of Health, Education, and Welfare, Office for Civil Rights OCR-72-8 Fall 1970), p. 202–204.

Column 3 was calculated by dividing the figure in column 2 by the five-state total at the bottom of column 2.

Column 4 was calculated from *Persons of Spanish Origin in the United States: March 1973* (U. S. Department of Commerce, Bureau of the Census, Current Population Reports, Series P-20, No. 264, May 1974).

Chicano freshmen enter two-year colleges (Table 2-13, Col. 2), and then apparently do not transfer to four-year colleges. As with Blacks all across the country, this will be an important factor in developing any plan to attract Mexican Americans into engineering.

TABLE 2-13

Freshmen Enrollments in Southwest by Type of School, 1970-1973

TYPE OF INSTITUTION (COLLEGE, ETC.)	MEXICAN AMERICAN FRESHMEN IN SOUTHWEST 1970	ALL FRESHMEN IN SOUTHWEST 1970	ALL FRESHMEN NATIONALLY, 1973
(1)	(2)	(3)	(4)
Public 2-year	75%	63%	38%
Public 4-year	18%	29%	38%
Private 2- and 4-year	8%	8%	24%

SOURCES: Cols. 2 and 3 come from *Access to College for Mexican Americans in the Southwest* (Princeton, N. J.: College Entrance Examination Board, Higher Education Surveys Report No. 6, July 1970), p. 19 (Table 3).

Col. 4 is computed from *The American College Freshman: National Norms for Fall 1973* (Los Angeles: Cooperative Institutional Research Program of The American Council on Education and the University of California at Los Angeles), Table 3, p. 11. The year 1973 was used because the percentages in columns 2 and 3 were very stable over the period 1971-1973.

During the period 1971–1973, the percentages of Chicano freshmen entering two-year colleges versus four-year colleges have remained fairly close to the levels shown in Column 2 of Table 2-13. It is clear from Table 2-13 that Chicanos are not enjoying equal access to four-year institutions either in the Southwest or in the nation as a whole.

Other Factors

The role of women in Spanish-speaking families (this includes both Chicanos and Puerto Ricans) may limit their interest and possible participation

in engineering. On the average, these women do not have as much education as the men, which contrasts with the experience among Blacks and whites in the U. S. Spanish American women are more likely to have large families and to stay home until their children are grown. But it may be significant that among younger Chicano and Puerto Rican women (age 10-24) the proportion which can read and write English is now equal to that among men of the same age, or 9 out of 10.[38]

Another relevant factor is that the Spanish Americans (again meaning Chicanos and Puerto Ricans) are much younger than the U. S. population at large. Their median age was estimated as 20 years in 1972, while that for the entire nation was 28.[39] As the *Manpower Report of the President* for 1973 pointed out, "Because of the large proportion of Americans of Spanish origin in the younger age groups (coupled with the expectation of rapid population growth from continued immigration and high birth rates), the representation of this ethnic group in the population and labor force and in school enrollments will continue to mount."[40] Accordingly, higher education and engineering education can expect an increasingly larger pool of Mexican American students.

TABLE 2-14

Puerto Rican and Chicano High School Completion, by Age Group, 1972

Age Group	Percentage Completing Four Years of High School or More			
	TOTAL U.S. POPULATION	PUERTO RICAN	CHICANO	TOTAL SPANISH ORIGIN
(1)	(2)	(3)	(4)	(5)
25–29 years old	79.8%	30.9%	42.9%	47.6%
30–34 years old	73.9%	22.6%	40.1%	42.7%
35–44 years old	66.8%	27.2%	28.0%	35.2%
45–54 years old	59.8%	21.3%	14.2%	24.9%
Total, 25 years and older	58.2%	23.7%	25.8%	33.0%

NOTE: Col. 5, Total Spanish Origin, includes other persons of Spanish Origin, not shown separately. Percentages for 55–64 years old and 65 years and older are not shown because the Puerto Rican data base was less than 75,000.

SOURCE: *Selected Characteristics of Persons and Families of Mexican, Puerto Rican, and other Spanish Origin: March, 1972* (Washington, D.C.: U. S. Department of Commerce, Bureau of the Census, Current Population Reports, Series P-20, No. 238, July 1972), p. 5.

THE EDUCATION OF PUERTO RICAN AMERICANS

In April 1973 a federal task force (FICE), looking at higher education among disadvantaged minorities in the U. S., wrote that the educational picture presented by Puerto Ricans is even worse than that of Chicanos. In fact, they wrote: " . . . educationally speaking, Puerto Ricans are worse off than any other single Spanish ethnic group."[41] This situation is illustrated by Table 2-14 which shows some of the findings from a March 1972 population survey conducted by the census bureau.

At almost all age levels, Puerto Ricans fell below Chicanos in the percentages of those who had completed four years of high school or more. In New York and New Jersey, the two states with the largest Puerto Rican populations, the 1970 census showed that the median number of years of school completed by people over 25 years of age was one to two years lower for Puerto Ricans than for Mexican Americans in three southwestern states, and 3½ years lower than that of the total U. S. population

There is also a greater problem with illiteracy in English among Puerto Ricans than Chicanos. A 1969 census study found that 40% of Puerto Ricans over 25 years of age said that they could not read and write English, while only 28% of Chicanos were correspondingly illiterate. In the 10- to 24-year-old group, the figure was 20% for Puerto Ricans but only 5% for Chicanos.[42]

The Puerto Ricans' educational situation is best examined in New York and New Jersey, where both their total populations and their school populations are heaviest (Table 2-15). In fact, nearly three-fourths (73%) of the Puerto Ricans in the mainland U. S. live in these two states. Almost three-fifths (58.8%) of all Puerto Ricans here live in New York City.[43]

Puerto Ricans' low educational attainment in New York and New Jersey is clearly illustrated in Table 2-16, which shows them significantly behind whites and Blacks in the median number years of school completed and in the proportions completing four years of high school, one year of college, and four years of college.

As Table 2-16 reveals, more than half of all persons 25 years or over in New York and New Jersey in 1970 had finished four years of high school or more, but less than 21% of Puerto Ricans had done so. Three-fourths of all those in the 25-29 age bracket had that much education, compared to just over 30% of the Puerto Ricans. And a very small share of Puerto Ricans had completed college—about one-tenth of the percentage in the general population.

Younger Puerto Ricans are better educated than their elders, which follows a pattern observed in other population groups as well. This shows up in Table 2-16 in the difference between 25- to 29-year-olds in 1970 and all those over 25. In addition, among the 18-24 age group 36% of the Puerto Ricans had graduated from high school. Chicanos of the same age group in the Southwest included 52% who were high school graduates.[44]

Not unexpectedly, the proportion of Puerto Ricans in the college age bracket (18-24) enrolled in college is very small. The FICE task force reported

TABLE 2-15

States with the Largest Puerto Rican Population and School Enrollment, 1970

State	POPULATION		School Enrollment					
			ELEMENTARY		HIGH SCHOOL		COLLEGE	
	NUMBER	PERCENT	NUMBER	PERCENT	NUMBER	PERCENT	NUMBER	PERCENT
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
New York	878,980	63.2%	182,441	61.9%	59,818	65.9%	9,140	51.6%
New Jersey	136,937	9.8%	29,611	10.0%	6,781	7.5%	1,253	7.1%
Illinois	88,244	6.3%	20,590	7.0%	5,576	6.1%	769	4.3%
California	46,955	3.3%	8,817	3.0%	3,190	3.5%	1,176	6.6%
Pennsylvania	44,947	3.2%	11,371	3.9%	2,569	2.8%	484	2.7%
Connecticut	38,493	2.8%	8,827	3.0%	2,119	2.3%	368	2.1%
Florida	29,588	2.1%	5,626	1.9%	1,974	2.2%	739	4.2%
Massachusetts	24,561	1.8%	5,307	1.8%	864	1.0%	368	2.1%
Ohio	21,147	1.5%	5,305	1.8%	1,916	2.1%	342	1.9%
Total U.S.	1,391,463	100.0%	294,785	100.0%	90,822	100.0%	17,705	100.0%

NOTE: The March 1973 census bureau study of Spanish Americans shows the total number of Puerto Ricans as 1,548,000. See "Persons of Spanish Origin in the United States: March 1973" (Washington, D.C.: U. S. Dept. of Commerce, Bureau of the Census, Current Population Reports, Series P-20, No. 264, May 1974), p. 9, Table L.

SOURCE: *Puerto Ricans in the United States* (Washington, D.C.: U. S. Department of Commerce, Bureau of the Census, 1970 Census of Population Report PC(2)-1E, June 1973), pp. 1 (Col. 2) and 36–38 (Cols. 4, 6, and 8).

TABLE 2-16

Educational Attainment of Persons 25 and over, and 25 to 29, in New York and New Jersey, 1970

Ethnic Group	% Completing 4 Years of High School or More		Percent Completing At Least 1 Year of College		Percent Completing 4 Years of College or More		Median Years of School Completed	
	25 AND OVER	25-29	25 AND OVER	25-29	25 AND OVER	25-29	25 AND OVER	25-29
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
All Races	52.6%	74.2%	21.2%	33.5%	11.9%	19.0%	12.1%	12.6%
White	54.2%	76.8%	22.3%	36.3%	12.6%	20.9%	12.1%	12.7%
Black	38.9%	57.1%	10.5%	13.9%	4.2%	4.9%	10.8%	12.2%
Puerto Rican	20.8%	30.3%	4.1%	5.1%	1.3%	1.5%	8.5%	9.9%

NOTE: "Puerto Ricans" refers to persons of Puerto Rican birth or parentage. Of the 1,008,147 Puerto Ricans identified in the source documents in New York and New Jersey in 1970, 92.0% were white, 6.2% Negro (Black), and 1.8% of other races. Data for whites and Negroes include Puerto Ricans.

SOURCE: Table comes from *Task Force Report on Higher Education for Chicanos, Puerto Ricans, and American Indians* (an unpublished report of the Federal Interagency Committee on Education's Task Force on Higher Education for Disadvantaged Minorities, April 1973), p. 44. It utilizes data from *Detailed Characteristics* (Washington, D.C.: U. S. Department of Commerce, Bureau of the Census, 1970 Census of Population Series PC(1)-D, State Reports Nos. 32 and 34, Table 148.

that their share was only about one-fourth that of the overall population in New York and New Jersey.[45]

Nearly 60% of all Puerto Ricans in the U. S. who attended elementary school, high school, or college in 1970 were in New York City.[46] Accordingly, a closer look at the Puerto Ricans' experience in that city will give us an insight into education as it affects a majority of Puerto Ricans in this country. The following information comes principally from the New York State Education Department; a two-year study conducted by the New York State Commission on the Quality, Cost, and Financing of Elementary Education (published in 1973 under the title *The Fleischmann Report*); the Board of Education of the City of New York; and the City University of New York (CUNY).

Unfortunately, the picture in New York City reinforces the impression nationally that Puerto Ricans are not receiving sufficient quantity or quality in their education. A high dropout rate is apparent. In terms of their proportion in the population, Puerto Ricans are underrepresented in the academic high schools and overrepresented in the vocational high schools of the city, which leaves them at a disadvantage in attempting to enter or succeed in college. Language is a persistent problem—nearly 40% of the Puerto Rican students in New York City public schools use English so poorly that they get very little out of attending schools with no bilingual programs. And at the college level, despite the improved opportunities with open admission to CUNY, Puerto Ricans have the lowest enrollment percentage out of their pool of high school graduates of any major ethnic group.

The next four subsections describe these problems as they are encountered in the New York City public schools. Any study of New York City education must also include an analysis of private schools since more than a quarter of the city's students attend these schools (26.7% in 1970–1971).[47] While 42.7% of white students attend private schools, only 11.8% of the Spanish-surnamed students in New York City do, so we can see that Puerto Ricans are heavily dependent upon public education.

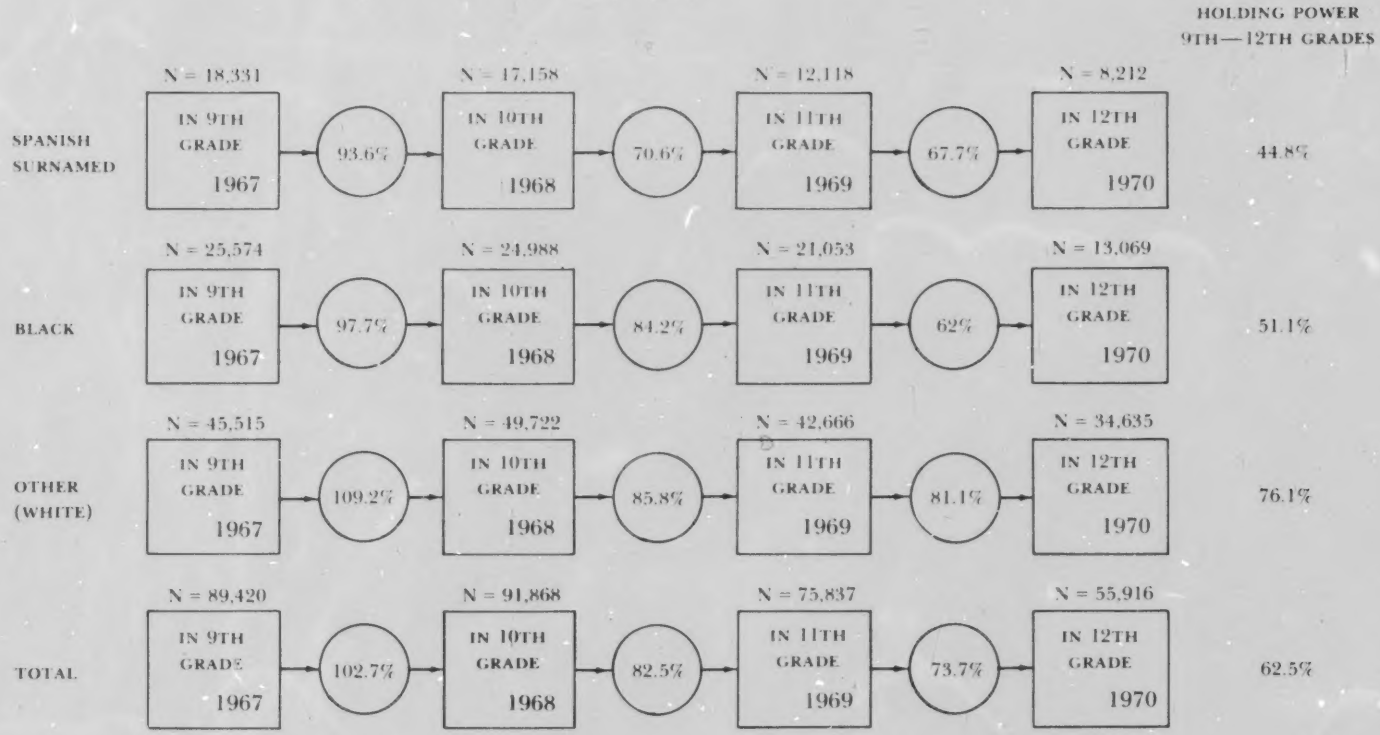
High Dropout Rates

"Dropping out of high school (and even elementary school), as well as falling behind in grade account for about two-thirds of the Puerto Ricans' underrepresentation in college," the FICE task force noted. It reported that in New York and New Jersey only 77% of Puerto Ricans aged 16 and 17 were in school in 1970, while in the population at large 91% of all the popoulation that age attended school. (In addition, a Puerto Rican was four times as likely to be two or more years behind in his school grade by age 16 than any student who was not Puerto Rican.)[48]

More than half (52%) of the Puerto Ricans in the high school class of 1971 dropped out of New York City public schools between the 10th and 12th grades, according to an analysis by the Fleischmann Commission. As shown in Figure 2-2, the holding power (the ratio of senior enrollment to freshman enrollment three

FIGURE 2-2

Student Retention Among Minorities in New York City Public High Schools, 1967-1970



NOTE: Numbers on top of boxes indicate the number of students enrolled in each grade in the fall of the year indicated, obtained from source below. Numbers in circles indicate the percentage of students completing the step from one box to the next: Only 67.7% of Spanish 11th graders, for example, enrolled in 12th grade the following year. The 52% dropout rate for Spanish-surname students between 10th and 12th grades is illustrated here—of the 17,158 10th graders in 1968, only 8,212, or 48%, remain in 1970.

SOURCE: Numbers obtained from, and percentages derived from, *The Fleischmann Report*, Volume I (New York: The Viking Press, 1973), p. 37, Table 1.19.

years earlier) for Spanish-surnamed students (predominantly Puerto Rican) was the lowest of the three major ethnic groups in the city, and only 59% of that for the predominantly white group (labeled "Other").

These data clearly indicate that if significantly larger numbers of Puerto Ricans are to be attracted to college and to engineering, much effort will have to be devoted to increasing the number of Puerto Ricans who complete high school.

Overrepresentation in Vocational Education

Puerto Ricans have the lowest proportion of students of any ethnic group in the academic high schools of New York City, and the highest proportion in the vocational high schools (Table 2-17). This clearly leaves a large number of Puerto Ricans in poor position to pursue a college education.[49]

TABLE 2-17

Ethnic Distribution of New York City Students in Academic and Vocational High Schools, 1972

Type of School	Ethnic Group						
	PUERTO RICAN	OTHER SPANISH	BLACK	AMERICAN INDIAN	ORIENTAL	OTHERS	TOTAL
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Academic	42,149 (74.2%)	8,968 (91.2%)	85,813 (85.0%)	122 (85.3%)	4,561 (90.1%)	118,476 (90.8%)	260,089 (85.8%)
Vocational	14,659 (25.8%)	866 (8.8%)	15,131 (15.0%)	21 (14.7%)	501 (9.9%)	11,945 (9.2%)	43,123 (14.2%)
Ratio Academic to Vocational	2.9:1	10.4:1	5.7:1	5.8:1	9.1:1	9.9:1	6.0:1

SOURCE: *Annual Census of School Population, October 31, 1972*, Summary Tables (New York: Board of Education of the City of New York, Office of Business Affairs, Pub. #353, December 1973), p. 6, Table 1.

A student decides whether to take the academic or vocational route in eighth or ninth grade, depending upon whether his school is part of a 4-4-4 sequence or a 6-3-3 system (the city schools are changing from the latter to the former pattern). Accordingly, it is apparent that students with the potential for college work, but who might be counseled to enter a vocational high school, must be reached with the proper educational materials and suitable advice in advance of the time they might be channeled into nonacademic work.

Language Difficulties

Nearly two-fifths (38.7%) of Puerto Rican children attending New York City public schools in the fall of 1970 had moderate or severe difficulty with the English language—more than 2½ times the citywide proportion. This included 63,311 students with moderate difficulty and 31,489 with severe difficulty.[50]

One would actually expect the language barrier to be more severe for Puerto Ricans than Chicanos. Mexican Americans have been moving to the U. S. in relatively large numbers for the last 60 years, so that many represent third-generation families. But only in the last 25 years have substantial numbers of Puerto Ricans immigrated to the mainland, so that few have lived here for more than a generation.[51]

And yet the Fleischmann Commission reported that bilingual teaching (which includes efforts to serve children with Chinese, Italian, French, and other backgrounds) "reaches only 4,000 students in New York City." We can only echo the Commission's comment on that fact: "It is no wonder that Puerto Rican students are scoring poorly on standardized tests, dropping out of school at an extraordinary rate (52% between 10th and 12th grades), failing to take advantage of postsecondary school opportunities, and finding it very difficult to compete in the job market."[52]

Low College Enrollment

Accurate counts of Puerto Rican college enrollment are difficult to arrive at. The census data in Table 2-15 indicate that there were 10,393 Puerto Ricans in college in New York and New Jersey in 1970. The FICE task force, on the other hand, estimated that only 7,900 enrolled in college from those two states among all 18- to 24-year-olds, only one-fourth of the proportion among all persons in that age bracket.[53]

Nevertheless, there is evidence that college enrollment is increasing. At CUNY the number of Puerto Ricans in the undergraduate student body has almost tripled since 1969 (Table 2-18). Puerto Rican representation in the total student body has nearly doubled as well, and has more than doubled if only matriculated students are counted.

CUNY officials estimated from New York State Education Department data that 9,862 Puerto Rican and other Spanish-surnamed men and women graduated from New York City public and nonpublic high schools in 1973. That fall, an estimated 5,358 Puerto Rican and Spanish-surnamed freshmen enrolled at CUNY.[54] If these freshmen had all been graduates of New York City schools, they would have represented 54.3% of that year's graduates in that ethnic group.

That percentage seems high when compared to national figures. According to federal estimates, only about 60% of *all* high school graduates enter college, counting full-time and part-time students pursuing degrees. In 1970, for example, the number of first-time college students in the fall was 61.4% of the number of high school graduates that year. In 1972, the number was 57.7% of

TABLE 2-18

City University of New York Puerto Rican Enrollment

YEAR	PUERTO RICAN STUDENTS	PERCENTAGE OF PUERTO RICANS IN UNDERGRADUATE STUDENT BODY	PERCENTAGE OF PUERTO RICANS AMONG STUDENTS MATRICULATED
(1)	(2)	(3)	(4)
1969	5,425	4.0%	3.8%
1970	7,626	4.8%	5.0%
1971	10,620	5.9%	6.1%
1972	13,563	6.9%	7.2%
1973	15,707	7.5%	8.0%

SOURCE: *Report of the Fall 1973 Undergraduate Ethnic Census* (New York: The City University of New York), pp. 2–3, 5. Numbers came from a voluntary survey. Approximately 55% of the students responded. Numbers above were arrived at by applying the percentage distribution of respondents to the enrollment reported by college registrars.

the high school graduates.[55] But the CUNY percentage is not so high when looked at in relation to enrollment records of other students. A study of New York City students who graduated from public and private high schools in 1970 and 1971 showed that about three-fourths were full-time students the year after graduation (75.7% in 1970, 73% in 1971). But Puerto Ricans had the lowest proportion of any ethnic group identified (63.1% in 1970, 62% in 1971). Other groups listed included Latin Americans, Blacks, Whites, and Orientals and "Other."[56]

That even 62% of Puerto Rican high school graduates in New York City are attending college is encouraging. It can safely be assumed that one factor contributing to this finding is the severe selection process occurring in the high schools, where more than half drop out between the sophomore and senior years. Those who survive this period are probably motivated, if not prepared, for college work.[57]

The Task Force has been unable to find any satisfactory data on college retention rates for Puerto Rican students. Such information should be collected in the future in order to permit accurate accounting of the opportunities for and performance by Puerto Ricans in higher education.

Until better data become available, some suggestion of Puerto Rican persistence in college comes from CUNY. Almost seven out of every 10 students (69.5%) who entered CUNY when "open admissions" began in 1970 were still enrolled four semesters later. Even among students with high school grade averages below the 70th percentile, a majority (57.6%) was still in school at the

time of the study.[58] From this we may estimate that more than half, and perhaps as many as two-thirds, of Puerto Ricans at CUNY continued college education for at least two years.

THE EDUCATION OF AMERICAN INDIANS

Late in 1969 a special U. S. Senate subcommittee completed a two-year study of the education of American Indians.[59] It concluded that

> . . . our national policies for educating American Indians are a failure of national proportions. They have not offered Indian children—either in years past or today—an educational opportunity anywhere near equal to that offered the great bulk of American children.

The following year, a special Presidential message to Congress[60] put the Indians' plight even more strongly:

> The first Americans—the Indians—are the most deprived and most isolated minority group in our nation. On virtually every scale of measurement—employment, income, education, health—the condition of the Indian people ranks at the bottom.

No one really disputes the truth of these statements, but consistent data proving their validity are difficult to come by. The two major sources of statistical information on Indians, the Bureau of Indian Affairs (BIA) and the Bureau of the Census, each use different definitions for "Indian," cover different geographic areas, and exclude significant (and unknown) proportions of the Indian population.[61] The BIA, for example, considers an Indian someone who is a member of a federally-recognized tribe and who lives on or near a federal reservation; for some purposes the person must also be of one-fourth or more Indian descent. This definition of course ignores many of the Indians who live in urban areas (approximately 45%, according to the 1970 Census).[62] On the other hand, the 1970 Census listed as Indian anyone who so designated himself or herself, or who reported being a member of an Indian tribe. But the census only sampled the population of about half the Indian reservations, so the reservation population was undoubtedly undercounted.

Because of this undercount, 1970 Census data on Indians' educational achievement are not really comparable with those for other minorities or the nation at large. The measures obtained for Indians are probably artificially high since the census missed such a large share of the reservation population, and particularly Indians living on smaller reservations where educational opportunities might be more limited. But if the census measures are inflated they are still disconcertingly low. Table 2-19, for example, shows that in 1970, 52.4% of all Americans over 25 had completed high school, but that only 33.5% of the American Indians had. The proportion of those completing high school was higher in the younger age groups, as has been the case with the other minorities.

TABLE 2-19

American Indian High School Completion, by Age Group, 1970

Age Group	Percentage Completing Four Years of High School or More	
	TOTAL U. S. POPULATION	AMERICAN INDIAN
(1)	(2)	(3)
25–29 years old	73.8%	50.1%
30–34 years old	68.8%	43.6%
35–44 years old	61.7%	37.2%
45–54 years old	54.2%	25.5%
55–64 years old	40.4%	23.3%
65 years and older	27.3%	12.8%
Total 25 years and older	52.4%	33.5%

SOURCE: *Educational Attainment* (Washington, D.C.: U. S. Dept. of Commerce Bureau of the Census, 1970 Census of Population Report PC(2)-5B, March 1973, Table 1, pp. 1–3.

TABLE 2-20

Educational Attainment of Indians 25 and over, and 25 to 29, in U. S., 1970

Ethnic group	Percent Completing at Least 1 Year of College		Percent Completing 4 Years of College or More		Median Years of School Completed	
	25 AND OVER	25-29	25 AND OVER	25-29	25 AND OVER	25-29
(1)	(2)	(3)	(4)	(5)	(6)	(7)
All Races	21.3%	32.0%	10.6%	16.2%	12.1%	12.6%
American Indian	11.1%	15.8%	3.6%	4.3%	9.9%	12.0%

SOURCE: *Educational Attainment* (Washington, D.C.: U. S. Dept. of Commerce, Bureau of the Census, 1970 Census of Population Report PC(2)-5B, March 1973), Table 1.

Three other measures of educational attainment are displayed in Table 2-20—completion of one year of college and four years or more of college, and median number of years of school. Indians fell short of the 1970 national averages on all counts and were particularly low in percentages completing college.

Indian education is unlike that of any other ethnic or racial group in that the federal government provides schooling through a special BIA school system for many Indians. Among students 5–18 years old tallied by the BIA,[63] more than a quarter (25.6%) attended federally funded BIA schools in 1972–1973 and the rest were enrolled in church-run mission schools or other institutions. But the BIA tally does not include Indian children in nine states where the states' educational systems are responsible for schooling.

The study by the special Senate subcommittee did not provide a systematic review of the academic performance of Indians in public schools.[64] However, the isolated examples cited in that study probably give a fair indication of the overall situation: public school dropout rates for Indians between 45 and 90%, and significant numbers of Indian students unable to read in the eighth grade, or reading two to six grades below the median level. The performance of Indians attending BIA schools was not very encouraging either. These are some findings from an outside study summarized by the subcommittee:[65]

> Only 60 percent of the Indian students in BIA high schools graduate, compared with a national average of 74 percent. Of the number of students who graduate from high school, only 28 percent enter college, as compared with a national average of 50 percent. Of those students who enter college, only 28 percent graduate . . . less than 1 percent of Indian graduate students complete a master's degree.

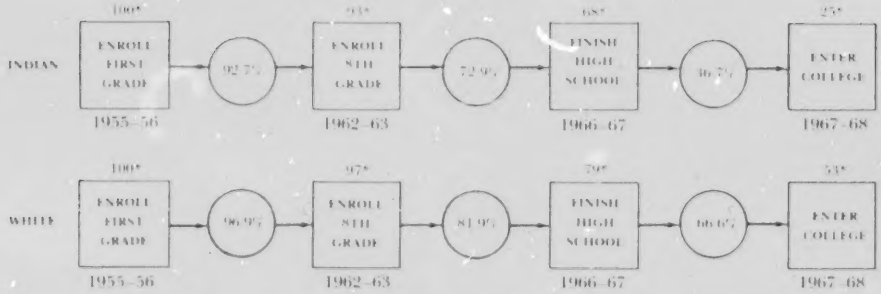
If these figures hold true today, they mean that only 13% of Indians who enter BIA high schools as freshmen manage to complete college.

A high dropout rate among Indian high school students was confirmed by a careful sampling of schools in Arizona, Nevada, New Mexico, Oklahoma, southern Colorado, and southern Utah.[66] The Southwestern Cooperative Educational Laboratory traced individual children in the eighth grade during 1962 for the following four years, covering BIA, private, and public schools. They found that 38.7% of the students dropped out between eighth and 12th grades (30.6% between ninth and 12th). The sample was designed to be representative of the tribes, schools, and communities in the six-state area. Dropout percentages were approximately the same no matter which type of school students attended.

The six-state study does not permit us to compare Indian retention in school with retention of other racial groups. But the U. S. Civil Rights Commission's studies in the Southwest did give data for whites as well as Indians in one state, New Mexico. Figure 2-3 compares Indians and whites in New Mexico, and tracks the progress of 1955 first graders until the Fall of 1967, when most would have entered college. At every level the proportion of Indians in school was sig-

FIGURE 2-3

Indian Student Progress in New Mexico, 1955-1968



*Numbers on top of each box represent progress of a hypothetical group of 100 students enrolling in the first grade.

NOTE: Numbers in circles indicate the percentages of students completing the step from one box to the next.

SOURCE: Derived from *The Unfinished Education: Outcomes for Minorities in the Five Southwestern States* (Washington, D.C.: U. S. Commission on Civil Rights, Mexican American Educational Series Report II, October 1971), p. 18, Fig. 5.

nificantly less than that of whites. The loss of students was particularly pronounced between high school and college, where the Indian rate of college entry was only half that of whites.

These findings do not take into account another problem we have observed with the other minorities as well, that the average school achievement of Indian children, whether they attend public or BIA schools, is two or three years below that of the national average by the time they graduate from high school.[67]

Although a small proportion of Indian students gets into college, once Indians are enrolled their attrition is not very different from other minority students', according to the federal task force which examined higher education among Chicanos, Puerto Ricans, and American Indians.[68] The FICE task force reported a BIA estimate of 25,000 Indian college students in 1972–1973, and cited a BIA survey showing that increasing percentages of Indian high school graduates were entering college. In 1972 the percentage was 42% in the BIA sample, compared to a national average for all high school graduates of 49%.

Special programs in fields such as law and medicine[69] are beginning to draw more Indians into the professions. Tribes are recognizing more and more that they need the special expertise that professionally trained Indians can offer. **Programs in engineering education which meet the particular needs of Indian communities and students should be able to attract more students into the field. But it is clear from Indians' precollege experience that more of them will**

have to receive adequate elementary and high school education before substantially larger numbers of Indians can enter technical and professional fields.

The Task Force therefore accepts the premise that American Indians are disadvantaged educationally, and that if a comprehensive nationwide study were undertaken it would show that their schooling was at least as deficient as that of the Mexican Americans and Puerto Ricans.

For comparison with earlier tables, Table 2-21 lists the nine states with the most American Indians, according to the 1970 Census. These states include almost two-thirds (65.6%) of all the Indians counted.

It must be borne in mind, however, that the numbers shown are lower than they should be. They do not include significant numbers of reservation Indians, and also probably omit many nonreservation Indians who could "pass" as some other ethnic or racial group or who simply did not want to be identified as Indian.

According to the census,[70] Indians are a small minority, representing only 0.39% of the 1970 U. S. total. In only two states did they make up more than 5% of the total population (New Mexico, 7.2%, and Arizona, 5.4%). Nevertheless, the Indian population is growing rapidly. It increased by more than half (51.4%) between 1960 and 1970, while the U. S. population as a whole grew only 13%.[71]

There are several factors which contribute to the educational difficulties faced by American Indians. Some of them are summarized in the following subsections:

White Ways Are Alien to Indians

The way most white Americans live conflicts rather drastically with the way many American Indians live or would like to live. Accordingly, American education puts many stresses on Indian students—sometimes more than they can bear.

Perhaps most fundamental is the conflict between a white American's attitude toward himself and others, and the comparable attitude on the part of an Indian.[72] The "successful" white is competitive, takes initiative, and strives to accomplish things as an individual, often at the expense of others. An Indian raised in the traditional manner, on the other hand, is expected by his parents and his tribe to be cooperative and to develop strong interpersonal ties. As one Indian has put it,[73] "The goals of American higher education to a very large degree are out of tune and in conflict with the Indian's psychological and philosophical frame of reference." The same can be said for precollege education.

Very relevant to the school situation are the close family and tribal ties a traditional Indian feels. Only about one-fifth of all Indians identified in the 1970 Census failed to list a tribal affiliation.[74] When possible, traditional Indians live as part of an extended family which includes aunts, uncles, grandparents, and other relatives.[75] All generations contribute to a child's education and upbring-

TABLE 2-21

States with the Largest American Indian Population and School Enrollment, 1970

State	Population		School Enrollment					
			ELEMENTARY		HIGH SCHOOL		COLLEGE	
	NUMBER	PERCENT	NUMBER	PERCENT	NUMBER	PERCENT	NUMBER	PERCENT
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Oklahoma	98,468	12.4%	19,096	11.6%	8,140	13.9%	1,845	13.0%
Arizona	95,812	12.1%	22,815	13.9%	8,043	13.8%	1,272	9.0%
California	91,018	11.5%	15,745	9.6%	6,272	10.7%	2,671	18.8%
New Mexico	72,788	9.2%	18,336	11.2%	6,084	10.4%	606	4.3%
No. Carolina	44,406	5.6%	9,728	5.9%	3,358	5.7%	350	2.5%
Washington	33,386	4.2%	7,012	4.3%	2,324	4.0%	534	3.8%
So. Dakota	32,365	4.1%	7,499	4.6%	2,806	4.8%	220	1.6%
New York	28,355	3.6%	4,074	2.5%	1,722	2.9%	683	4.8%
Minnesota	23,128	2.9%	5,651	3.4%	1,690	2.9%	262	1.8%
Total U.S.	792,730	100%	163,996	100%	58,543	100%	14,191	100%

SOURCE: *American Indians* (Washington, D.C.: U. S. Dept. of Commerce, Bureau of the Census, 1970 Census of Population Subject Report PC(2)-1F, June, 1973), Table 3, pp. 21–26.

ing. And yet nearly two-thirds (65.8%) of the children in BIA schools during the 1972–1973 school year were required to board there.[76] This means they were cut off from their families and tribes for months at a time, which undoubtedly accounts for some of the children's difficulties in school.[77]

There are other important conflicts, too. The American Indians believe in sharing the land with all other living things, and in leaving it as they found it in the beginning. They could be called the original ecologists of the Western Hemisphere; they have been historically at odds with technology where it has involved pollution, depletion of resources, destruction of the landscape, and so on.[78]

The sum effect of these differences, and other ones we have not even mentioned, is to make it difficult for an Indian raised in traditional ways to fit into American education as a "successful" student. To be successful he may actually have to "fail" as an Indian by adopting values far different from those of his family or tribe.

Indians Seldom Control Indian Education

Until recently, Indians had very little control over the education prescribed for their children, whether they lived on reservations or not.[79] Not only did many children have to go to BIA boarding schools but BIA educational programs depended upon low federal appropriations and Indians had little say in the programs. The Senate subcommittee found numerous public school districts educating Indians where there were no Indians on the school board.

Today there is a move among American Indians to take more control of the educational process for their children.[80] Indians want to run their own schools, colleges, and universities on reservations, and they want control of programs run elsewhere specifically for Indians. They want to develop curricula and textbooks suitable for many tribes and for single tribes when necessary. They want federal and foundation money channeled through tribal councils or Indian educational organizations to insure Indian control of programs being supported.

It seems likely that with greater Indian control of education, more students will be able to receive college preparation and college education.[81] As a result, there should be a correspondingly larger pool of Indians who could go into engineering. An outside study of BIA schools[82] found that three-fourths of students surveyed wanted to go to college and that most understood what college work required. They wanted to be firmly grounded in English, mathematics, and science, for example. But the BIA teachers and administrators reportedly did not consider academic achievement an important goal for their students. The Senate subcommittee noted that teacher expectations seriously affect student achievement, and commented that this "self-fulfilling prophecy of failure seems to be a pervasive element in BIA schools."[83] Indian leadership could presumably help overcome this tendency toward failure.

300 Language Barriers

If English is a problem for Chicanos and Puerto Ricans, imagine what it is for Indian children. Spanish can be mastered by a teacher determined to use it, but Indian languages are more difficult and there are far more of them—the Senate subcommittee estimated there were 300 separate ones.[84]

The failure to provide bilingual and bicultural education for Indian children obviously leaves them at a great disadvantage. Nearly one-third of the Indians sampled for the 1970 Census (31.9%) listed an Indian language as their mother tongue, meaning the language spoken at home when the respondent was a child.[85] The subcommittee said the BIA claimed one-half or more of Indian students entering school had little or no skill in English. The subcommittee also said that most public school teachers are not trained to teach it as a second language.[86] And it stated that 40,000 Navajos, nearly one-third of the whole tribe, were functionally illiterate in English.[87] A report cited by the FICE task force indicated that 87% of 50,000 Navajo children could not use English when they entered first grade and half knew no English at all.[88]

If the diverse Indian languages cause educational problems, so do tribal differences. The 1970 Census identified 90 major tribal groupings, some with numerous subdivisions.[89] American Indians are therefore not a single, unified minority but a heterogeneous grouping of many sub-minorities whose cultures, traditions, and habits of life vary tremendously. Educational programs must be designed to deal with individual tribes, not Indians as a single unit.

These are just a few of the obstacles which have stood in the way of American Indians seeking better education. Until they are taken into account, and a substantial share of Indians receive far better precollege education, the pool of potential American Indian engineers will remain limited.

CONCLUSION

This excursion into the nonengineering education of the four underrepresented minorities has been lengthy but has served an essential purpose. It has demonstrated that efforts to recruit Black engineering students can draw upon a reasonably large pool of Blacks who are already college-bound, but that long-term efforts to increase the numbers of Mexican Americans, Puerto Ricans, and American Indians will require extensive changes in American education, essentially outside engineering education, to improve considerably the elementary, high school, and general college education of these minorities.

3

Engineering Education and Minorities in Engineering

In order to understand the nature of the problems which must be faced in increasing the participation of Blacks, Chicanos, Puerto Ricans and American Indians in engineering, it is necessary to understand the process by which engineers are educated in this country. After surveying the interest, enrollments, attrition, and transfer patterns of engineering students in general, we present a brief assessment of the current involvement of engineering education in the production of minority engineers.

INTEREST IN ENGINEERING

Engineering is the largest professional occupation for men in the United States, employing more than a million persons. Engineering enrollments and bachelor's degree production, however, have been declining for several years at the same time that demand and opportunities for new engineers have been growing rapidly. Most of the fluctuations in engineering enrollments are due to the changes in military veteran enrollments, the end of the draft and draft deferments for engineering students, and the cutbacks in defense and space program funding which resulted in well-publicized layoffs in the aerospace sector.

In an analysis of engineering enrollments,[1] a committee of the American Society for Engineering Education concluded, among other things, that:

1. The process by which young people select careers is very complicated and begins early in life with the junior high school level recognized as a critical choice point for potential engineers.
2. Substantial numbers of engineers are produced by all socio-economic levels and predictive models based on socio-economic origin of engineering students have little value.
3. There is little likelihood that the field of engineering can substantially increase the percentage of the very bright students it attracts since other fields draw competitively from the same source of manpower.

Because engineering is a prestigious profession, trailing only medicine and law in popularity,[2] many young people are initially attracted to pursue it. A study of 20,000 male high school students by the Commission on Human Resources and Advanced Education showed that nearly a third (32.9%) of the ninth-grade males indicated career preferences in science or engineering but that, four years later, interest in these fields had dropped to only 13.5%. Their study, which appears in the 1970 report, *Human Resources and Higher Education*, by Folger, Astin and Bayer,[3] used data from Project TALENT,[4] a national longitudinal study of American youth, and found that two thirds of the ninth-grade students changed their initial career choice to another one by the end of high school. They concluded that "... career plans of high school freshmen are rather unstable." In Table 3-1, taken from their report, we see that only 20% of those choosing engineering as ninth graders were still interested in it by the end of high school.

TABLE 3-1

Career Choice Distribution of Males in the Ninth Grade and One Year after High School

FIELD	1960 NINTH GRADE		1964 ONE YEAR AFTER HIGH SCHOOL		NET GAINS AND LOSSES IN PERCENTAGE POINTS	STABILITY RATE*
	NUMBER	PER CENT	NUMBER	PER CENT		
1. Natural Sciences	2,008	10.4	879	4.5	− 5.9	12.4
2. Engineering	4,359	22.5	1,746	9.0	− 13.5	**20.0**
3. Business	1,158	6.0	2,710	14.0	+ 8.0	35.1
4. Health—M.D. and D.D.S.	1,233	6.4	819	4.2	− 2.2	26.3
5. Law	793	4.1	659	3.4	− 0.7	20.9
6. Clergy	392	2.0	291	1.5	− 0.5	28.8
7. Arts	382	2.0	621	3.2	+ 1.2	25.4
8. Teaching	864	4.5	1,790	9.2	+ 4.7	27.0
9. Skilled and Technical	5,176	26.7	4,374	22.6	− 4.1	34.0
10. Social Sciences and Services	167	1.0	367	1.9	+ 0.9	3.0
11. Other	2,830	14.6	5,106	26.4	+ 11.8	33.0

*The stability rate is the percentage of the initial group who had the same career choice at the initial and follow-up period.

SOURCE: Table 6.1 of Folger, Astin & Bayer, *Human Resources and Higher Education*, Russell Sage Foundation, N.Y., 1970.

By comparing ninth-grade career interests of high school boys with their interests one year after high school, Folger, Astin and Bayer observed that students who shifted out of natural sciences tended to go into engineering and that those who shifted out of engineering tended to go into business, a field also perceived as having "entrepreneurial" appeal. In Table 3-2, which is taken from their report, the patterns of shifting student interest among ten fields are shown in detail.

TABLE 3-2

Proportion of High School Boys Shifting from Each Field between the Ninth Grade and One Year after High School

FIELD CHOICE IN THE NINTH GRADE	FIELD CHOICE ONE YEAR AFTER HIGH SCHOOL										
	1	2	3	4	5	6	7	8	9	10	11
	(PERCENTAGES)										
1. Natural Sciences	**12.4**	10.7	9.7	6.4	3.4	1.0	3.4	10.4	15.2	3.8	23.5
2. Engineering	5.0	**20.0**	13.0	3.0	3.0	1.0	2.0	8.0	21.0	1.0	23.0
3. Business	3.7	3.6	**35.1**	1.9	2.6	1.2	2.3	8.1	16.0	1.4	24.0
4. Health—M.D. and D.D.S.	2.1	5.6	12.7	**26.3**	5.4	0.6	2.2	8.3	14.4	3.2	18.8
5. Law	2.0	4.0	16.0	4.0	**20.9**	2.0	3.0	11.0	13.0	2.0	21.9
6. Clergy	3.1	3.1	8.9	3.1	5.1	**28.8**	3.1	11.0	12.0	4.1	17.9
7. Arts	1.6	1.8	10.2	1.3	1.8	1.0	**25.4**	11.5	13.6	3.7	28.0
8. Teaching	3.0	3.0	13.0	3.0	2.0	1.0	3.0	**27.0**	17.0	4.1	23.9
9. Skilled/Technical	3.1	5.8	12.6	1.5	1.7	0.6	2.0	7.0	**34.0**	1.5	30.2
10. Social Sciences and Services	3.6	1.8	13.8	1.8	5.4	1.8	3.0	6.0	20.3	**3.0**	39.5
11. Other	4.0	6.0	14.0	2.0	2.0	1.0	5.0	9.0	23.0	1.0	**33.0**

SOURCE: Table 6.2 of Folger, Astin and Bayer, *Human Resources and Higher Education*, Russell Sage Foundation, N.Y. 1970; based on Project TALENT data.

The entries in Table 3-2 are percentages and sum to 100% when added across each row. Reading across the second row we can see which of the ten fields the ninth graders who started out in Engineering ended up in four years later: for example, only 1% of them ended up respectively in Columns 6 or 10 representing the Clergy and Social/Service fields while 13% gravitated toward Business.

It is also informative to read down the second column, for Engineering, in Table 3-2 to get a feeling for the original interests of those students who switch toward Engineering during high school. For example, 10.7% of the Natural

Science and 5.8% of the Skilled/Technical freshmen ended up choosing Engineering as did 6% of the "Other" category. Even though the career and interest plans of high school freshmen are so unstable, those students who do maintain the same career plans between the ninth and twelfth grade in high school appear also to remain more stable in their measured interests later on.[5] Moreover, the American Council on Education has found that initial career expectation and intended major are the best predictors of future career outcomes for college freshmen.[6]

Because the high school years are so important in career development, the Commission on Human Resources conducted a study on the prediction of career plans of high school seniors from information about their ninth-grade personal characteristics, academic subjects and types of high schools.[7] They found that measured interests and initial career choices were the most potent predictors and that knowing a student's interests and other personal orientations at the ninth grade increased the likelihood of predicting his career choice at the end of high school. They observed that:

> . . . the engineering aspirants showed an earlier interest in physical science, tended to choose college preparatory curricula, possessed mathematical information, and were likely in the ninth grade to choose engineering as a career.

In a special *Engineering Manpower Bulletin* entitled "What's Different About Engineering Students?" John Alden reviewed a 1972 survey of 51,500 Indiana high school seniors conducted to ascertain their educational and vocational plans.[8] Although the findings pertain only to students in that state, there were over 2,000 students who gave engineering as their vocational choice and another 1,200 who indicated that they planned to become technicians. Alden observed that most (57%) of the high school seniors choosing engineering had good grades and had pursued college preparatory courses but that a large (16%) number of them had taken general or vocational programs not specifically aimed at equipping students for admission to an engineering college. At the same time, a surprisingly high (41%) proportion of the technician students had taken a college preparatory course in high school and could presumably be admissible in an engineering program. Taken together, these statistics indicate that there is probably confusion in the minds of students about the difference between engineers and technicians, the educational preparation involved, and the different college admission requirements for the two types of programs. In addition, there seemed to be a surprising lack of understanding among both engineering and technician aspirants about the appropriate level and duration of college education required for those careers. Only 50% of the engineers and 13% of the technicians indicated plans to enroll in B.S. degree programs, while 22% and 58%, respectively, planned college programs of less than four years duration.

Nearly three quarters of the Indiana seniors interested in engineering came from families whose head had less than two years of college. Engineering students were the most likely group to come from families with professional and

technical backgrounds, although they also had a strong input from families headed by skilled workers.

In Table 3-3 we compare the school year at which the Indiana students first became interested in a vocation and the year when they actually decided to pursue that career.

TABLE 3-3

School Year of Career Interest and Career Decision

(Percentages of Students)

VOCATIONAL CHOICE	GRADES 1-6	GRADES 7-8	GRADE 9	GRADE 10	GRADE 11	GRADE 12
Engineer						
First Interest	10	19	14	16	22	18
Actual Decision	*2*	*4*	*5*	*9*	*24*	*53*
Technician						
First Interest	7	11	11	16	25	28
Actual Decision	*1*	*2*	*3*	*7*	*20*	*64*
High School Teacher						
First Interest	14	20	15	15	22	13
Actual Decision	*2*	*4*	*6*	*9*	*24*	*51*
All Vocations						
First Interest	11	14	13	16	23	19
Actual Decision	*2*	*3*	*5*	*8*	*21*	*53*

The engineers became interested over a wide range of years with a slight peaking of interest at the junior year of high school. By the junior year 44% had actually decided upon engineering careers. These figures indicate the importance of providing sound career guidance information at all levels, especially from the seventh grade up, in order to stimulate students' interest in engineering.

When asked about the sources or people who were most helpful in making a career choice, the Indiana seniors responded as shown in Table 3-4.

The importance of having a personal example or role model to identify with is shown by the high percentage of students who were influenced by a teacher to select teaching as a career. The statistics also reflect the importance of having close exposure to a field through parents or friends. Only family influence stands out as strongly affecting the career choices of engineering and technician students, but the uniformity of the citations of the other factors means they must all be utilized in an effective recruiting campaign.

TABLE 3-4

Person or Source Most Helpful in Making Career Choice

VOCATIONAL CHOICE	RELATIVE	FRIEND	H.S. COURSES	WORK EXPERIENCE	TV, RADIO PRINTED MATERIAL	H.S. TEACHER	GUIDANCE COUNSELOR
Engineer	32%	12%	14%	12%	14%	7%	7%
Technician	27	17	10	10	18	8	8
H.S. Teacher	20	10	18	12	6	27	5
Managerial	33	16	7	23	9	7	4
Service	30	30	3	7	16	3	5
Skilled Worker	30	18	8	21	6	10	4
Agricultural	30	15	3	29	13	4	3
Clerical	24	11	32	8	7	13	6

TABLE 3-5

Most Important Reason for Choosing a Career

VOCATIONAL CHOICE	ACTIVITIES ON THE JOB	MONEY	PEOPLE I'LL WORK WITH	SERVING SOCIETY	LIKE TO WORK OUTDOORS	STATUS OR PRESTIGE
Engineer	51%	22%	4%	5%	6%	6%
Technician	43	20	7	15	3	5
H.S. Teacher	42	4	29	17	2	2
Managerial	43	23	14	4	4	6
Service	35	13	19	15	3	3
Skilled Worker	43	27	5	2	10	3
Agricultural	26	5	2	2	61	1
Clerical	47	21	17	3	1	4

In Table 3-5 are itemized the most important reasons given by students for choosing a particular career field.

Those Indiana students selecting engineering mentioned, in rank order, activities on the job (51%), money (22%), outdoor work (6%) and prestige (6%). Alden noted that these reasons set engineering students quite apart from those planning to become high school teachers, who gave as their reasons: activities on the job (42%), people worked with (29%), and serving society (17%). This contrast of engineers and high school teaching aspirants is interesting since the two groups are very similar in their academic abilities, preparation and background. As the engineering profession becomes more and more concerned with the needs of society and expands to include more people-oriented, inter-disciplinary, team approaches to solving mankind's problems, it may well be that these attributes will draw more and more bright, well-prepared youngsters into the field.

The engineering profession has a responsibility to make high school students, their families, teachers and counselors aware of opportunities for fulfilling work in engineering. This awareness must be achieved before that first critical decision point, usually the ninth grade, when students must choose the type of high school curriculum they intend to follow. Fortunately, there is an increasing awareness of this responsibility and opportunity within the engineering establishment so that many efforts to reach high school and pre-high school youngsters are now under way. The April 1974 issue of *Engineering Education* is devoted entirely to guidance and recruiting problems and describes a variety of informational and academic programs, and efforts to coordinate them, in order to attract and retain able youngsters for engineering careers.[9]

The second critical decision point which confronts a high school student occurs during the twelfth grade when he must decide whether to pursue higher

education, to seek a job or to enter the military service. We shall next focus our attention on those young people interested in engineering who decide to enter college. But, first, we shall let the cat out of the bag a little and acknowledge that many students who graduate from high school with an interest in engineering change their minds before enrolling in college and that many more change their minds during college and after college.

Project TALENT data show that during a single year between twelfth grade and one year out of high school, the proportion of boys in the sample planning to be engineers dropped from 16.6% to 8.9%.[10] Thus, even at the time of college entry the career plans of young people are quite malleable and subject to influence by a new set of educational and interpersonal experiences.

A high proportion of students, perhaps two-thirds of them,[11] also change their career plans at least once during their college years. In their five-and ten-year followups of 1961 college freshmen, Astin, El-Khawas and Bisconti[12] found that the proportion of men who planned to be engineers underwent a steady decline from 15% as freshmen to 10% five years later to only 6% at the end of ten years. The flow of men from physical scientist and mathematician careers into engineering during the college years was about the only source of recruitment to engineering over time but did not compensate for the engineering majors who abandoned the field. A five-year followup by the same investigators of 1966 freshmen revealed a similar falling off of interest in engineering. In Table 3-6, taken from their report,[13] we can see the shifts in career plans of college men over the four year period from 1966 to 1970.

Reading across line 8 in the table, we see that only 41% of the males choosing Engineering as freshmen are still planning on engineering careers four years later. Once again, a significant number (19%) of them have changed to Business. Reading down Column 8, we see that 7% of the Research Scientist, 11% of the Health Professional and 6% of the Undecided male freshmen ended up in Engineering at the end of four years. These statistics suggest that there is still an opportunity to attract good students into engineering during the college years. It should be emphasized to the large number of current freshmen aspiring to health and science careers that engineering is a receptive and accessible undergraduate major already being used by significant numbers of their classmates.

In the final year of their follow up, 1970 to 1971, Astin, El-Khawas and Bisconti found the exodus from engineering still going on. Of those hardy male 1966 college freshmen who were still in engineering in 1970, only 64% had remained in engineering by 1971, an exodus of 36% in just one year! About 15% of those 1970 "seniors" who left engineering by 1971 indicated career interests in business[14] and this reflects the generally accurate perception that engineering is an attractive undergraduate major for those aspiring to business or management careers.

Having surveyed the shifting interest of initially interested students away from engineering, we shall now examine in more detail the enrollment and progress of students pursuing engineering degrees in college.

TABLE 3-6

Shifts in Career Plans (1966 to 1970) of 1966 Male College Freshmen

(In percentages; N = 462, 239)

CAREER PLANS IN 1966	CAREER PLANS IN 1970†															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1. Physician	39	6	4	*	3	*	5	1	7	1	3	10	2	–	14	6
2. Dentist	7	27	1	0	*	0	4	*	12	1	6	17	4	–	15	6
3. Research Scientist	3	1	25	0	2	*	10	7	2	1	6	11	3	–	20	10
4. Statistician	0	0	3	0	0	0	4	0	4	3	5	53	0	–	26	4
5. Clinical Psychologist	0	0	1	0	12	10	12	0	5	1	11	16	2	–	8	24
6. Social Worker	0	0	0	0	2	24	6	*	4	1	7	16	2	–	32	6
7. College Teacher	1	0	1	0	1	*	31	1	6	0	19	5	6	–	20	10
8. Engineer	1	*	3	*	*	*	3	41	3	1	5	19	2	–	15	7
9. Lawyer	1	0	*	0	*	1	6	1	47	0	3	16	2	–	19	5
10. Health Professional	7	0	3	0	0	0	7	11	1	15	6	19	*	–	22	9
11. Elementary/Secondary School Teacher	*	*	1	0	*	2	11	*	1	1	41	10	3	–	23	7
12. Business Executive or Owner	1	*	1	0	1	1	5	2	8	*	3	45	3	–	23	7
13. Artist	*	0	1	*	2	*	8	4	2	1	9	11	39	–	13	10
14. Housewife	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
15. All others	1	1	2	*	*	1	5	3	5	2	6	18	3	–	44	9
16. Undecided	3	2	2	0	4	1	5	6	6	*	10	12	4	–	23	21

†Numbers under *Career Plans in 1970* refer to same categories listed under *Career Plans in 1966*.

HIGHER EDUCATION FOR ENGINEERS

In spite of the fact that engineers and engineering educators are "number oriented" and make careers out of quantifying and measuring things, surprisingly little is known about the educational flow patterns of engineering students in this country. We must echo the lament of the American Society for Engineering Education that:

> Very few engineering deans have hard facts concerning the reasons for dropouts and transfers, and even fewer have indicated that they are planning to investigate the variables which might account for engineering attrition.[15]

The Sources of Data

There are essentially three sources of information and data concerning engineering education: the Engineering Manpower Commission (EMC) of the Engineers Joint Council in New York, headed by John Alden; the American Society for Engineering Education (ASEE) in Washington; and the American Council on Education (ACE), also in Washington.

Each year EMC publishes the engineering enrollments and degrees awarded by the country's 285 engineering schools from data reported by engineering deans and certified by their registrars.[16] In addition to this annual reporting, EMC issues frequent, informative bulletins and newsletters on selected developments affecting engineering and technical manpower.

About every ten years or so, the ASEE commissions a high-level panel to report on engineering enrollments. The last report was done in 1965 and one is presently underway with data now being gathered.[17] Almost every issue of the monthly ASEE journal, *Engineering Education*, however, has several articles on enrollment, retention, curricula and guidance aspects of engineering education.

The ACE, as part of its Cooperative Institutional Research Program, has each year since 1966 published *The American Freshman: National Norms*. These reports present estimates of the enrollment patterns and interests of the full-time freshmen who enter the country's 2,588 colleges and universities each autumn.[18]

Certainly, the EMC data on engineering school enrollments and degrees is the most reliable data available and is used in most government and engineering education studies. However, it contains no information about non-engineering colleges and junior colleges through which a large number of students begin their engineering careers, nor does it reveal attrition or retention figures for either transfer or "native" engineering students. The ASEE reports on engineering retention are thorough enough but are quite old (1959 freshmen!) and often are based on local "case studies" not easily generalized to national trends. The ACE numbers and norms are derived from a stratified sample of student questionnaires administered early in the autumn on about 360 campuses and are subject to the usual caveats about vagaries in student responses and stratification

methods.[19] Still, ACE is at present the only source of data on freshmen engineering majors in all two and four-year schools, and on their racial characteristics. Moreover, under the sponsorship of the National Science Foundation (NSF), ACE has done several major follow-up studies where the subsequent academic careers of freshmen have been tracked for as long as a decade.

From these principal sources of data and occasional tidbits from other sources we have constructed the following mosaic of the status of engineering education as it is today.

Those Who Start Out in Engineering

In 1973, almost 1.65 million students enrolled as full-time, first-time, college freshmen with about 41% of them entering two-year or community colleges, 36% entering four-year colleges and 23% entering universities. In each of these types of institutions about 6%, 5% and 10% respectively of the entering students declared engineering as their "most probable major."[20] We have found it convenient to display this numerical data in a block diagram form, Figure 3-1, which may be visualized as a flow-chart or educational pipeline chronicling the pathway through which students progress into engineering.

FIGURE 3-1

Flow Patterns of 1973 Freshmen Into Engineering

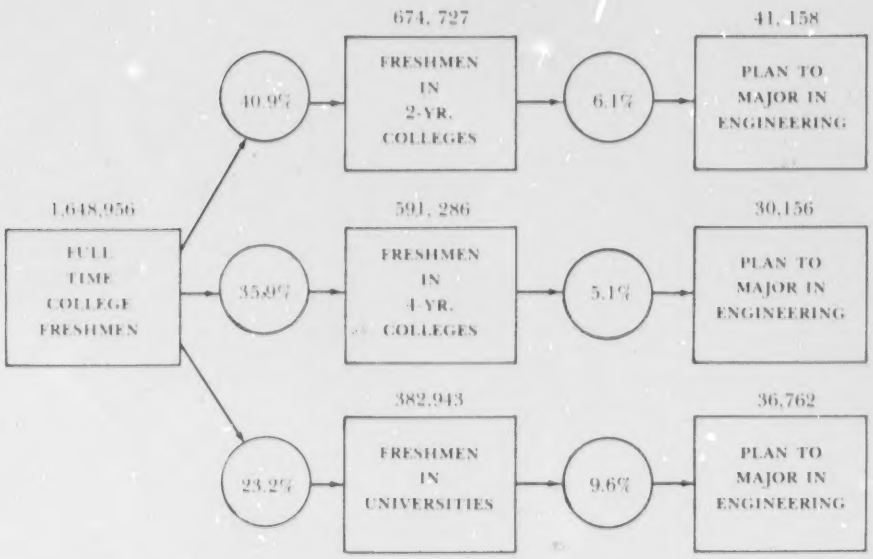


TABLE 3-7

College Enrollment and Freshmen Majoring in Engineering

YEAR	FULL TIME COLLEGE FRESHMEN	PERCENT OF FRESHMEN ENTERING 2-YR. COLLEGE	PERCENT OF FRESHMEN ENTERING 4-YR. COLLEGE	PERCENT OF FRESHMEN ENTERING UNIVERSITIES	PERCENT IN 2-YR. COLLEGE CHOOSING ENGINEERING	PERCENT IN 4-YR. COLLEGE CHOOSING ENGINEERING	PERCENT IN UNIVERSITIES CHOOSING ENGINEERING
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1966	1,163,123	24.9%	45.3%	29.7%	11.2%	7.2%	12.7%
1967	1,359,883	30.9%	42.9%	26.3%	10.9%	7.1%	11.9%
1968	1,472,929	30.1%	40.5%	29.5%	9.9%	7.8%	12.3%
1969	1,637,831	35.7%	35.6%	27.7%	11.5%	8.0%	11.7%
1970	1,617,324	35.6%	39.7%	24.7%	7.2%	8.2%	11.4%
1971	1,634,160	39.5%	37.5%	23.0%	8.2%	5.4%	8.5%
1972	1,557,512	39.0%	37.9%	23.9%	7.1%	6.2%	7.6%
1973	1,648,956	40.9%	35.9%	23.2%	6.1%	5.1%	9.6%

In the diagram of Figure 3-1, each box represents a way station or progress point of students and the number over the box is the number of students actually at that point. The circles are envisioned as "flow factors" and inside them we write the percentage of students who make it from the box on the left of that circle to the next progress point box on the right of the circle. The arrows are drawn to indicate the order or direction in which the students progress from one milestone to the next. Thus, the uppermost pathway in Figure 3-1 shows that of the 1,648,956 freshmen entering college in 1973, 40.9% of them, or 674,727 students, enrolled in a two-year college and of that number, 6.1%, or 41,158, chose engineering as their major field of study.

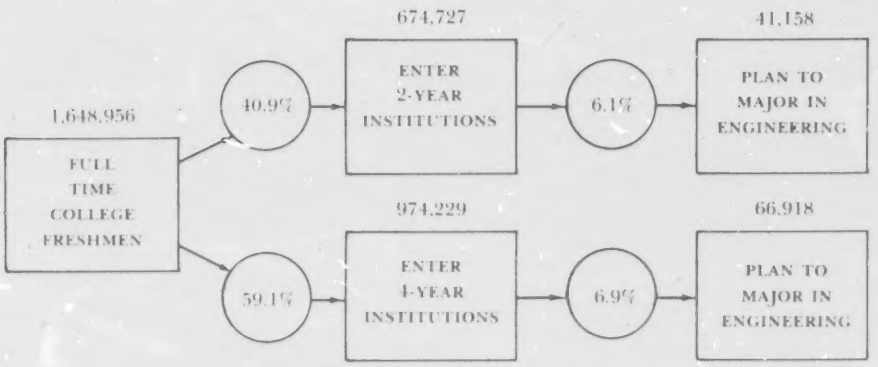
To see how the various numbers and flow patterns, shown in Figure 3-1 for 1973 have been evolving over time, we have constructed Table 3-7 using ACE reports for the eight years that they have been conducting their survey.[21]

It is quite clear from Table 3-7 that more and more freshmen are beginning their college careers in two-year colleges and that in each type of institution there has been declining interest in engineering among college entrants.

Using Table 3-7, anyone who wants to can construct his own pictures like Figure 3-1 to see how any particular class of freshmen flowed into engineering majors that year. Drawing the boxes and circles, it is simple for one to write down the number of entering freshmen on top of the first box and fill in the percentages inside the circles from the entries in Table 3-7. Then just multiplying away (taking the percentages), the corresponding numbers of freshmen at the next milestone are gotten and written on top of the next boxes on the right. Proceeding in this fashion, working from left to right, one soon has his own flow chart with all of the information displayed as in Figure 3-1.

FIGURE 3-2

Simplified Presentation of 1973 Flow Patterns Into Engineering



Now, Figure 3-1 was drawn that way because ACE data is broken out by two-year colleges, four-year colleges and universities. Since we are interested in engineering education, it is convenient to lump together[22] the two lower four-year pathways into just one pathway representing all four-year institutions, as we show in Figure 3-2.

But all engineering schools are four-year institutions and each year EMC tells us how many freshmen there are enrolled in engineering schools; for example, in 1973 EMC says there were 51,925 freshmen in these schools. We can subtract these EMC freshmen from our ACE estimate of engineering freshmen in four-year institutions to get

$$66{,}918 - 51{,}925 = 14{,}993$$

and see that almost 15,000 freshmen planning to major in engineering began their schooling in non-engineering, four-year schools.

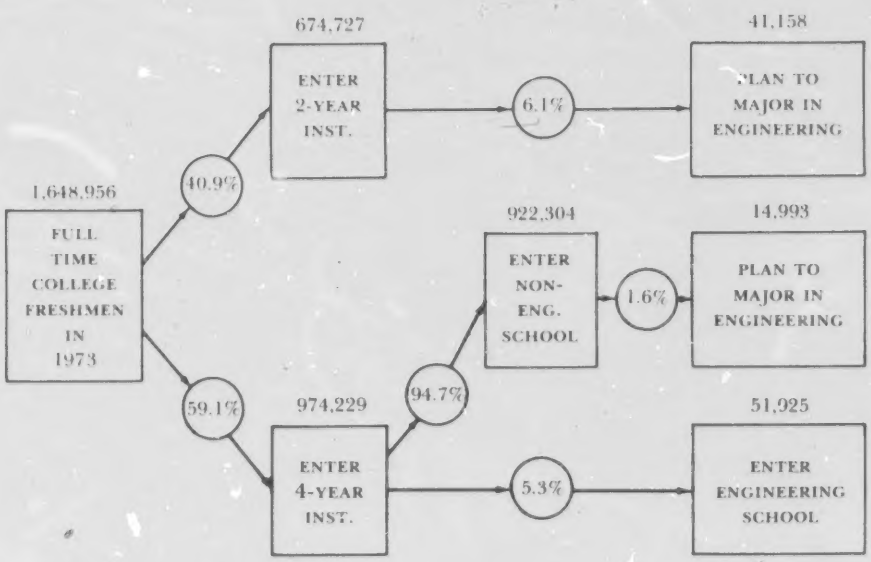
This leads us to consider a further modification of Figure 3-2 to construct the flow pattern diagram shown in Figure 3-3.[23]

Once again, it is instructive to observe how the flow patterns and numbers of students shown in Figure 3-3 have been changing over the past few years and this evolution is chronicled in Table 3-8.

From Table 3-8 and the simple diagrams of Figures 3-2 and 3-3, we can see that today more freshmen intending to major in engineering start out in colleges

FIGURE 3-3

The Relative Flow of 1973 Engineering Freshmen into Engineering and Non-Engineering Schools



which do not offer engineering than start out in engineering schools, and that 38% of all engineering freshmen are enrolling in junior or community colleges. Since the 38% who start out in junior colleges and the 14% who start out in nonengineering four-year schools must eventually transfer into engineering schools in order to become engineers, we can see that any attempt to understand engineering education in this country must include an analysis of transfer students. In the next two subsections we shall survey the current status of engineering colleges and the progress of both "native" and transfer students through their undergraduate programs.

Education in Engineering Schools

What happens to the 48% of the college freshmen majoring in engineering who begin their careers in an engineering college? First of all, about 80% of them will still be around for a second year in that institution although they may not still be interested in engineering.[24] In fact, after one year of college, only about 66% of the engineering freshmen are still interested in engineering while perhaps 12% of them have switched to other scientific majors.[25] Of course, some freshmen from other majors, perhaps 13% of the science majors, change their minds, too, and switch into engineering after their first year. Still, because fewer freshmen begin in science in the first place, there is a net flow out of engineering before the second year of college.

Although they may not remain in engineering, the freshmen who start out in engineering do seem to stay in college with slightly higher persistence rates than other majors, but they tend to take longer to graduate.[26] Those engineering freshmen who do remain in engineering and who eventually go on to earn bachelor's degrees in engineering are likely to take more than four years to do so. The data in Table 3-9, taken from an ACE ten-year follow-up of a group of 1961 college freshmen who started out in four-year schools,[27] shows quite clearly that, on the average, a bachelor's degree in engineering has been taking between 4.7 and 4.8 years to complete.

John Alden of the Engineering Manpower Commission[28] has also found that engineering degrees take closer to five years than to four years of engineering school for completion, and he uses the number 4.8 years for an average completion time. When we recall that about 40% of the total college freshmen majoring in engineering now start out in two-year colleges, and have to transfer into engineering schools in order to earn engineering degrees, we must expect that these students may take even longer to finish their studies.

In addition, about 12% of undergraduate engineering students are currently participating in the extremely successful cooperative education programs[29] which require periods of off-campus employment and they usually take five years to finish their studies. Taking all these factors into account, it seems clear that, on the average, five years is probably a good working number to use for the completion time of a B.S. in engineering. The Task Force applauds current efforts by engineering colleges to reduce requirements and bring the degree completion times of their matriculants down to around 4.2 years, a level comparable to many liberal arts curricula.

TABLE 3-8

Engineering Majors in Engineering and Nonengineering Schools

	1967	1968	1969	1970	1971	1972	1973
Number of Total Full-Time College Freshmen	1,359,883	1,472,929	1,637,631	1,617,324	1,634,160	1,557,512	1,648,956
Total Number of Freshmen in All Schools Majoring in Engineering	129,644	143,761	168,309	139,672	117,955	107,065	108,076
Percentage of Freshmen Entering Two-Year Colleges	30.9	30.1	35.7	35.6	39.5	39.0	40.9
Number of Freshmen in Two-Year Colleges	419,777	444,042	584,942	574,962	645,297	608,122	674,727
Percentage of Two-Year College Freshmen Majoring in Engineering	10.9	9.9	11.5	7.2	8.2	7.1	6.1
Number of Two-Year College Freshmen Majoring in Engineering	45,756	43,960	67,268	41,397	52,914	43,177	41,158
Percentage of Freshmen Engineering Majors Who Enroll in Two-Year Colleges*	35.3*	30.6*	39.9*	29.6*	44.9*	40.3*	38.1*
Percentage of Freshmen Entering All Four-Year Schools	69.2	70.0	64.3	64.4	60.5	61.0	59.1
Number of Freshmen in All Four-Year Schools	940,106	1,028,807	1,052,889	1,042,372	988,863	949,390	974,229
Percentage of All Four-Year School Freshmen Majoring in Engineering*	8.9*	9.8*	9.6*	9.4*	6.6*	6.7*	6.9*

Number of All Four-Year School Freshmen Majoring in Engineering	83,888	99,801	101,041	98,275	65,041	63,888	66,918
Percentage of all Four-Year School Freshmen Enrolling in Engrg. Schools	8.2	7.5	7.0	6.9	5.9	5.5	5.3
Number of Freshmen Enrolling in (Four-Year) Engineering Schools	77,551	77,484	74,113	71,661	58,566	52,100	51,925
Percentage of Freshman Engineering Majors Who Enroll in Engrg. Schools*	59.8*	53.9*	44.0*	51.3*	49.7*	48.7*	48.0*
Percentage of Four-Year School Freshmen Enrolling in Non-Engrg. Schools	91.8	92.5	93.0	92.9	94.1	94.5	94.7
Number of Four-Year School Freshmen Enrolling in Non-Engrg. Schools*	862,555*	951,403*	978,776*	970,711*	930,297*	897,290*	922,304*
Percentage of Freshmen in Four-Year Non-Engrg. Schools Majoring in Engrg.	0.7	2.3	2.8	2.7	0.7	1.3	1.6
Number of Freshmen in Four-Year Non-Engrg. Schools Majoring in Engrg.	6,337	22,317	26,328	26,614	6,475	11,788	14,993
Percentage of Freshmen Engrg. Majors Enrolling in Four-Yr. Non-Engrg. Schools*	4.9*	15.5*	16.1*	19.1*	5.4*	11.0*	13.8*

*Not depicted in Fig. 3-2 or Fig. 3-3; supplied here as additional information of interest.

Table 3-9

Completion Times of Engineering Baccalaureates Earned by Males Who Began in Four-year Schools in 1961

NUMBER OF YRS. TAKEN	YR. AWARDED BS DEGREE IN ENGINEERING	NUMBER FROM GROUP RECEIVING BS IN ENGINEERING THAT YEAR	PERCENTAGE OF ENG. GRADUATES WHO FINISHED THAT YEAR	CUMULATIVE PERCENTAGE WHO FINISHED BY THAT YEAR
1	1962	10	0.0%	0.0%
2	1963	114	0.3	0.3
3	1964	501	1.4	1.7
4	1965	16,073	45.8	47.5
5	1966	12,736	36.3	83.8
6	1967	3,557	7.3	91.1
7	1968	926	2.6	93.7
8	1969	331	0.9	94.6
9	1970	573	1.6	96.2
10	1971	960	2.7	98.9
	NO YEAR GIVEN	349	1.0	100.0

It is important to emphasize that successful engineering undergraduate study has been requiring close to five years for ordinary, mainstream, engineering college students instead of the nominal four years engineering educators aspire to. It is important because, in recent years, the only engineering students whose progress is being monitored and documented are those few minority students now in engineering, and the fact that they have often been taking longer than four years to graduate has led some observers to conclude that they are slower and less able, and therefore more costly to support than white students. **It is important to emphasize that those minority students taking five years to graduate in engineering have been performing comparably well with their white or Anglo counterparts and that financial aid programs should be based on financing five years of study instead of four.**

Now that we have seen that those who succeed in engineering schools seem to take five years in order to do it; what can we say about the likelihood that a student enrolling in an engineering school will be one of the successful ones and actually graduate in engineering? According to ASEE, based on a 1965 survey of fifty engineering schools,[30] the percentage of entering engineering students who got a degree in engineering in six years or less declined steadily from 63% in 1950 to 49% in 1959, as shown by Table 3-10.

It should be noted from the data in Table 3-10, which does not include students transferring as upperclassmen from other engineering schools or from

TABLE 3-10

Percent of Entering Freshmen Who Earn an Engineering Degree

TIME REQUIRED FOR GRADUATION IN ENGINEERING	ENTERING YEAR					
	1950	1952	1954	1956	1958	1959
4 years	46.3	42.2	39.0	34.9	37.0	35.7
4 to 5 years	15.2	16.2	13.2	15.6	13.7	12.4
5 to 6 years	1.4	2.4	4.0	2.8	2.9	0.6
TOTAL	62.9	60.8	56.2	53.3	53.6	48.7

junior colleges, that only 36% of the 1959 engineering school freshmen were able to finish engineering degrees in four years.

In an earlier (1960) survey of 92 engineering colleges,[31] the ASEE Sub-Committee on Dropouts of Engineering Students found that survival rates from freshman enrollment to the bachelor's degree averaged 36% for state universities and 55% for private colleges, but were as low as 20% for some state universities. They estimated that from 40–45% of the full-time entrants to engineering schools graduated from the institution of original entry.

In 1970 the Commission on Human Resources and Advanced Education reported[32] that the percentage of 1965 engineering school freshmen who graduated in engineering rose slightly to about 53%.

From the preceding discussion it is clear that about half of those who start out in engineering colleges actually earn degrees in engineering.

It is useful to try to determine the points in their studies where students in engineering schools are dropping out. Unfortunately no comprehensive year-by-year attrition studies are available. Most people who try to figure this out either do it for their own institution or else attempt to derive national year-by-year "retention" ratios from engineering enrollments published by the Engineering Manpower Commission[33] which we show in Table 3-11.

For example, it is tempting to divide the 1973 sophomore enrollment of 40,159 by the 1972 freshmen enrollment of 52,100 to get the ratio 0.771 and to interpret this as implying that 77% of the engineering school freshmen are remaining in engineering. This is misleading, however, because a glance at, say, 1973 seniors compared to 1972 juniors shows dramatically that these year-by-year enrollments are not even counting the same students. The enrollments for a given year include those students who have just transferred in, or gotten "left back," as well as those who survived the preceding year. Although the year-by-year enrollment ratios from EMC are useful in predicting enrollment patterns, budgets and degree production, they are of little use in understanding the year-by-year retention of students in engineering schools.

TABLE 3-11

Full-time Engineering College Enrollments

	1967	1968	1969	1970	1971	1972	1973
Freshman	77,551	77,484	74,113	71,661	58,566	52,100	51,925
Sophomore	56,975	55,615	52,972	53,419	47,948	42,272	40,519
Junior	50,483	50,274	50,039	49,855	48,543	45,874	41,673
Senior	47,551	50,736	51,738	51,983	51,377	49,895	48,366
5th yr.	4,589	5,133	4,668	4,812	4,391	4,586	4,222
Total Undergrad	237,149	240,806	233,530	231,730	210,825	194,727	186,705
M.S.	34,231	24,469	20,014	23,216	22,405	22,877	22,588
Ph.D.	15,376	15,768	14,298	14,802	14,100	13,460	11,904
Grad	49,607	40,237	34,312	38,018	36,505	36,337	34,492

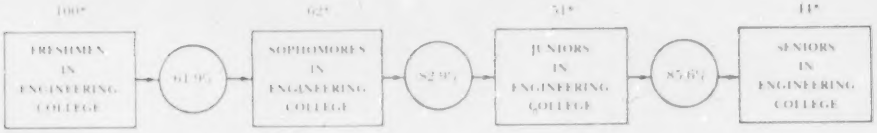
To really understand retention patterns a comprehensive longitudinal study would have to be done and a large sample of students actually followed up over a five- or six-year period. The ASEE study now underway (Reference 17) is utilizing follow-up questionnaires from engineering students, but only preliminary results of this study will be available by the summer of 1974. Not having such a study available, nor the time and resources to carry one out itself, the Task Force made a "quick and dirty" estimate of its own.

From a Spring 1972 survey of 160,000 students enrolled in 92 public and private colleges in California, including 22 engineering colleges, we selected a subsample of over 11,000 engineering students. From this subsample we determined the percentage of each class level which were transfer students, as we describe in greater detail in the next subsection on engineering transfers (see pp. 85 ff. and Reference 50). From the EMC engineering enrollments for California engineering schools in 1971, 1972, and 1973, we subtracted the appropriate percentages of each class which were transfers to get estimates of "native" enrollments for that three-year period. Dividing the adjusted class enrollment by the previous class enrollment one year earlier, we derived retention ratios for engineering students in California's engineering colleges. It is convenient to display this year-by-year retention data in the form of a flow diagram as in Figure 3-4.

Anyone who does a study on education in California is quickly advised that California students are likely to be considerably better off than students in less wealthy and less enlightened state educational systems. Still, there is little reason to believe that, once the effect of transfer students has been removed, California's engineering colleges are significantly different from engineering colleges in the rest of the country. Even if these colleges were somehow better off for being

FIGURE 3-4

The Retention Rates in California Engineering Schools



in California, the retention rates shown in Figure 3-4 are not much to brag about. They show dramatically the year-by-year exit of bright, well-prepared engineering students from engineering.

From Figure 3-4 we see that we lose almost 40% of our engineering school students in the first year and almost half of them by the end of two years. Out of every 100 students who enter engineering colleges as freshmen, only 62 make it to the sophomore year in engineering, only 51 make it to the junior year, and only 44 survive to the senior year in engineering. While it may be argued that attrition weeds out the unfit and unmotivated, many talented students are being lost too. **The challenge for engineering educators is not just one of attracting more able students to engineering schools, but also one of retaining more of the highly qualified students who do enroll.**

To gain some insights into the reasons why students drop out or flunk out of engineering schools, the Task Force turned to a 1971 study by the University of Alabama which surveyed 206 persons who had left the College of Engineering without a degree in the preceding four years.[34] While this case study was carried out at just one engineering school, the results agree closely with the experiences of many other engineering colleges and engineering educators who have investigated engineering attrition.[35] Of those students who dropped out, 42% had dropped out while classified as freshmen, 45% as sophomores, 11% as juniors and only 2% as seniors. One fifth of the dropouts left engineering before completing ten credit hours of course work.

The reasons given by students withdrawing from the College of Engineering were:

1. Academic problems 45%
2. Discord with professors and courses 40%
3. Personal and family problems 10%
4. Financial problems 5%

All of the students surveyed left engineering to work toward a degree in some other college or school at the University of Alabama. After leaving engineering, their grades either stayed the same or got markedly better with the low scorers in engineering showing the greatest improvements.

Sixty percent of the Alabama dropouts reported that their high school preparation had been inadequate for engineering study, while 40% viewed their

preparation as adequate. The percentages of students reporting areas of high school deficiencies were:

1. Mathematics 47%
2. Physical Sciences 33%
3. Natural Sciences 12%
4. Humanities 5%
5. Social Sciences 3%

Students who enrolled in remedial courses reported that 65% of the courses were not satisfactory preparation for the required professional engineering and cognate courses. Seventy-two percent considered the Mathematics Department as unsatisfactory with many expressing irritation over the advanced level of mathematics required initially and the "no-credit" status of the remedial math courses. The most-criticized courses in the engineering curriculum included engineering drawing (61%), physics (59%), and chemistry (59%). The students felt that engineering courses were too rigorous with too much material covered too rapidly to be intellectually digested within one semester.

One major item mentioned when asked to give candid opinions of the engineering faculty and curriculum was the "strict parochialism" of the engineering curriculum which effectively isolated the engineering students from the other students in the university. The complaint most often mentioned, by 95% of the students reporting, was "the cold impersonal attitude of the faculty displayed in the capacity of teaching and advising." "Ineptness and blatant unconcern for the student" was also a salient complaint by students.

When asked to comment upon their ideas of engineering before and after entering the College of Engineering, the Alabama students' greatest disparity centered around the major thrust of the engineering curriculum, which is a "theoretical approach with little practical application." Students were disappointed that they did not have the opportunity to practice the theoretical concepts in an application atmosphere.

As pointed out earlier, the harsh evaluations of the Alabama students of their engineering education are unfortunately applicable to most of the country's engineering colleges.

Back in 1963, a Special Committee on Student Attrition[36] of the Engineering Manpower Commission reported that very few engineering colleges had effective counseling systems and that often, in their handling of the students, the colleges were "haphazard, impersonal, mechanized, and lacking in any vital motivation." The EMC Committee felt that student mortality was as much a human motivational problem as an academic one and that "a student's attitude toward his studies is strongly colored by his environment, the encouragement he receives from his teachers, college morale, his social adaptation and other factors that influence his outlook." They also felt that the freshman or sophomore students particularly need "a sense of identity with the profession, a feeling of pride in being an engineer, an association with the engineering faculty, engagement in student activities, and a wholesome perspective of the profession."

The Committee on Student Attrition decided that greater curricular flexibility in the freshman year is essential to "allow for variations in students' academic background, and generally to enable faltering but conscientious students to get their feet under them." They found that "positive programs of tutorial assistance and remedial reading can be highly effective in helping students over initial hurdles," and that special summer preparation and, particularly, mathematics courses geared to the student's background, "can bring many students with relatively weak backgrounds up to acceptable levels of performance."

It is important to emphasize that, over a decade ago, engineering educators and experts were urging more engineering colleges to utilize summer programs, remedial and tutoring programs, personal interest by faculty, better orientation and counseling, and flexible freshman curricula just to meet the needs of their ordinary, mainstream, *predominantly white* engineering students. It is important to recognize that in our present-day advocacy of these very same mechanisms to increase minority student progress in engineering, we are only calling for things that engineering schools ought to be doing anyway. The same programs that are necessary to reduce attrition for white students must be provided for minority students. **The attention and "Tender Loving Care (TLC)" now known to be so successful in the education of minority engineering students should not be thought of as "affirmative actions" or costly frills but should instead be recognized as mainstream, state-of-the-art educational practices, and should be provided routinely for all engineering students.**

Our Task Force agrees with the Commission on Human Resources and Advanced Education, which concluded that:

> Whatever the causes of attrition—an overly rigorous curriculum, ineffective teaching practices, failure to hold the student's interest in an engineering career—engineering schools would do well to follow the example of medical schools which have recently made intensive studies of factors affecting retention of students in their programs.[37]

One encouraging aspect the Task Force observed in studying engineering colleges is the cooperative engineering curriculum, which has been recognized for more than fifty years as a means for obtaining a superior engineering education.[38] Students participating in a cooperative program alternate periods of study with periods of related work experiences in industry or other engineering employment. The early exposure to the real world of engineering work offers an effective means for attracting, motivating, and retaining engineering students. In the face of declining engineering enrollments nationally, several schools stressing cooperative programs have enjoyed stable and in some cases dramatically increased enrollments.[39] While 182 of the country's 285 engineering colleges, or 64% of the schools, now offer co-op programs, only about 12% of the country's engineering students are presently participating in them, even though industry is interested in greater participation.[40] It seems clear to this Task Force that engineering educators ought to make greater use of this widely available mechanism for increasing enrollments and retention of engineering students.

Now that we have some understanding of what happens to the students who enroll in engineering colleges, let us turn our attention to the 52% of the engineering majors who begin their studies in schools which do not offer engineering degrees.

Transfers into Engineering

It has been a long time since anyone has published nationally applicable data on the progress of transfer students in engineering. The U. S. Office of Education (USOE) used to survey the engineering colleges annually and publish the percentages of each class enrollment which were transfers into that class, but this survey has not been carried out since 1961.[41]

The most comprehensive study of students transferring into engineering was conducted by Knoell and Medsker and published in 1964 in the two landmark reports *Factors Affecting the Performance of Transfer Students from Two- to Four-Year Colleges*[42] and *Articulation Between Two-Year and Four-Year Colleges.*[43] In their three-year follow-up of nearly a thousand students who transferred in 1960 from junior colleges into engineering colleges, Knoell and Medsker found that 60% of these transfers successfully graduated with degrees in engineering.[44] Only 21% of the transfers into engineering were able to graduate within just two years, however, and 39% of them required between two and three years of upper division study to earn their engineering degrees. The engineering majors constituted 13% of the total transfer student entrants and they constituted 12% of the transfers who graduated within the three-year period. Of the total transfers into all colleges, 62% earned degrees within the three years, only 2% more than the transfers into engineering schools. Knoell and Medsker concluded that transfer students in engineering have as good a chance of obtaining bachelor's degrees as do transfers with other majors although they tended to take three rather than two years to complete their programs.[45]

How well do transfer students perform in engineering schools compared to their "native" classmates who have been there all along? Most of the engineering educators we asked tell us that the transfers hold their own.[46] Their grades are likely to go down their first term after transfer, but then rise to competitive levels after the students adjust to their new environments. Those "high ability" transfers who could have entered engineering schools as freshmen, but instead enrolled in junior colleges, do just as well as the natives, and those who would not have been admissible as freshmen seem to earn only slightly lower grades than the natives. Students who transfer after only one year of junior college do significantly poorer and have higher dropout rates than do students who complete two or more years of non-engineering college before transferring.[47]

In any discussion of transfer students, one question always pops up: "Should scholarships or other forms of financial aid be used to induce all (or most) high school graduates with high academic ability to enter four-year institutions as freshmen, even though they could attend a local two-year college for their lower division work without requiring such aid?" Deans of engineering

schools, worried about their declining freshmen enrollments and allegedly high attrition rates in junior colleges, are especially prone to this line of reasoning. With few exceptions, surveys of transfer students with high ability reveal that they value their junior college experience so much that they would not easily be induced to forego it.[48] They cite specifically the quality of the instruction they received in junior college, the interest of the teachers in the students and the opportunity to remain near families and friends during a period they regarded as one of immaturity and uncertainty. If the students themselves are to be believed, it does not appear that there is a pressing need to spend vast sums of money just to "save" all high ability students from beginning their careers in junior colleges. Of course those "ordinary" or "low" ability students, not normally admissible as freshmen by engineering colleges, who enroll in and survive junior college pre-engineering programs before transferring into engineering colleges are also quick to point out the value to them of the junior college education.

The studies just cited only deal with the *successful* transfer students, those who have already made it through two years of college math and science courses and gotten high enough grades to be admitted as transfers into engineering schools. It is nice to see that these students do so well in engineering school, but what percentage are they of all those freshmen engineering aspirants who started out in non-engineering colleges? Does an engineering freshman starting out in a non-engineering school have as good a chance to make it to the junior year of engineering school as his counterpart starting out as a freshman in an engineering school?

Unfortunately, we have no definitive junior college engineering attrition studies available to answer this question but there are several, indirect, related studies from which we can gain some understanding of what is going on.

First, in a survey of American graduate students conducted in 1968 by John Creager,[49] we can see that 28% of the country's engineering graduate students indicated that they had been transfer students as undergraduates. Now, in general, we expect that engineering graduate students represent the academically most successful of the undergraduate engineering students so it is quite revealing to see that between a fourth and a third of the best students were transfers.

Second, from an informal poll by the Task Force of several deans of engineering, we see that transfer students today comprise a substantial fraction of their upper division engineering enrollments and provide, in some instances, as much as 75% of their bachelor's degree production. Table 3-12 shows the deans' estimates of the percentage of their students who entered their engineering schools as transfers.

Third, to get further insights into the role of transfers, the Task Force did a computer analysis of the spring 1972 enrollment, by class, in the public and private colleges of California.[50] This survey included 7,805 full-time undergraduate engineering students of whom 679, or 8.7%, were Black, Chicano, American Indian, or Puerto Rican. The percentages of the students enrolled in four-year engineering colleges who were transfers is shown in Table 3-13.

TABLE 3-12

Percentage of 1974 Engineering B. S. Degree Recipients Who Entered as Transfers

ENGINEERING COLLEGE	PERCENTAGE
San Jose State Univ.	75%
Univ. of Florida	72%
Univ. of the Pacific	60%
U. C. Berkeley	60%
U.C.L.A.	50%
Stanford Univ.	27%
Univ. of Alabama	23%
Iowa St. Univ.	18%
Rensselaer Polytechnic Inst.	13%
Cornell Univ.	10%

Now, it is well-known that California has an outstanding system of community colleges and well-articulated transfer patterns between two-year colleges, the state colleges and state university systems, so that no one would pretend that what is true in California is what is happening in the rest of the country. In fact, in the east where more traditional engineering colleges predominate, transfers may only constitute from 10 to 30% of the enrollments.[51] Rather, the astonishingly high transfer component of engineering enrollment in California, especially for minority students, should probably be viewed as a picture of the way things are going to be in the rest of the country. As more and more states develop their community college systems and more and more engineering colleges develop recruiting and counseling networks with these two-year schools, we may expect to see transfer students constituting larger and larger shares of the engineering college enrollments.

We may safely conclude that today at least a fourth and perhaps a third of the upper division engineering students in the country began their careers in non-engineering colleges with most of the transfers having begun in junior colleges. Since, five years ago, between 40 and 50% of the freshmen who planned to major in engineering started out in non-engineering colleges, the fact that they now make up about 30% of the juniors and seniors tells us something about the retention rates of non-engineering school entrants. These figures suggest that the retention is lower, but not significantly lower, for those freshmen who start out in non-engineering colleges. Of course, most observers would expect lower retention patterns for non-engineering college entrants since they have to accomplish a change of institutions just to stay in their original major and there are many reasons, not all academic, why students intending to

TABLE 3-13

Transfer Student Component of 1972 Engineering Enrollments in California Engineering Colleges

CLASS STANDING	NUMBER OF FULL-TIME ENGINEERING STUDENTS	PERCENTAGE OF ENGINEERING STUDENTS WHO ENTERED AS TRANSFERS	NUMBER OF FULL-TIME MINORITY ENGINEERING STUDENTS	PERCENTAGE OF MINORITY ENG. STUDENTS WHO ENTERED AS TRANSFERS
Freshman	1120	8.6%	90	16.7%
Sophomore	1191	35.3%	94	45.7%
Junior	2235	63.6%	161	70.2%
Senior	2089	62.4%	131	69.5%
Fifth Year	426	64.1%	29	72.4%

transfer may eventually choose not to. Moreoever, it is generally believed that junior colleges have extremely high attrition rates since their entrance requirements are usually just a high school diploma and their entrants have average high school grades and standardized test scores much lower than the engineering colleges, which are highly selective. By virtue of the sheer numbers of students choosing to begin college in two-year colleges, however, the junior colleges actually enroll more of the country's high ability students than do the very selective schools.[32] It may well be the case that, as in other institutions, only the more able junior college students even consider engineering majors as freshmen and that for these students, retention is higher than for the overall junior college population.

It seems clear to the Task Force that students entering engineering careers by the transfer route will continue to be an important component of engineering education, especially as it relates to minorities who are entering junior colleges in disproportionately high numbers. By setting up effective pre-engineering guidance and articulation programs between the engineering schools and their non-engineering feeder schools, and by providing adequate financial aid for transfer students, the transfer student retention rates should increase and we should be able to channel even more of these welcome students into our engineering colleges.

MINORITIES IN ENGINEERING

In this section we shall review the current status of minorities in engineering education. Following a brief analysis of minority students' interest and enroll-

ment patterns, we develop tables of those engineering colleges which are today producing the largest numbers of Black, Chicano, Puerto Rican and American Indian engineers.

Minority Interest in Engineering

As usual, data on the individual minority groups is hard to come by. Combined with the paucity of educational data collected by engineering educators, this makes it doubly difficult to assess minority involvement in engineering education. Nevertheless, we can piece together some picture of what the current flow of minorities into engineering colleges appears to be.

The Task Force was unable to find any attitudinal or academic interest surveys of Chicano, Puerto Rican or American Indian youth relevant to engineering study,[53] but found one useful one for Blacks. The most comprehensive survey of Black high school students' characteristics and attitudes ever undertaken in this country was conducted in 1971 by the National Scholarship Service and Fund for Negro Students (NSSFNS), an organization that provides guidance services without cost to Black students who want to attend college.[54] In the spring of 1974 NSSFNS published a second study surveying a total of almost 80,000 Black seniors in the following high school classes of 1972 and 1973 but these studies involved smaller cohorts and did not survey as many additudinal items as did the landmark 1971 survey.[55] The 1971 NSSFNS survey studied 54,000 Black students in their senior year in 7,000 of America's 26,000 high schools. It represented more than 20% of the estimated 250,000 Black students in the class of 1971 and a large percentage of the Black full-time freshmen who entered college in the fall of 1971 and about whom we found related data.

Although the socio-economic backgrounds of college-bound Black students often differ markedly from those of white students, their academic and career aspirations do not, according to the NSSFNS survey. Some 32% of the Black students said they expected to end their formal education with a bachelor's degree, while 50% said they would seek a degree beyond the bachelor's level. These figures compare favorably to the 37% and 42% of the autumn 1971 college freshmen of all races who aspired to bachelor's and post-bachelor's degrees respectively.[56]

Only 6.2% of the Black high school seniors—14.6% of the males and 0.6% of the females—in the NSSFNS survey indicated that engineering would be their probable major field in college, while 10% said they would major in education and another 21% said they would major in business. An additional 3% of the students intended probable college majors in mathematics or statistics, 1.3% in the physical sciences, and 2.8% in "other technical fields." Along with the 6.2% in engineering, these students constitute a total pool of 13.3% of the Black college-bound youth who might be regarded as potential engineering freshmen that following autumn.

Asked to choose which among a list of life objectives they thought to be essential, 90% named "help my people," the most frequently chosen objective;

82% named "help others in times of trouble"; and 78% said they wanted to "become an authority in a special field." Scholastically, 60% of the students ranked in the top third of their high school classes, but only half considered themselves to be "smart" and only a third rated themselves intellectually as "much better than average." Some 36% expected to have taken a full four years of mathematics in high school and 42% had an average of B or better in math. Eighty-two percent said they were "satisfied" or "very satisfied" with high school; three-fourths felt their teachers were "smart"; but only 34% thought the teachers were "with it." Eighty-three percent believed that "success is a result of hard work"; 67% believed racial integration to be good, while only 6% opposed it; the rest were neutral. The three most frequently cited important reasons for going to college were to "learn more" (88%), "get a better job" (84%), and "fulfill need for trained Black people" (83%).

These findings were claimed by several Black leaders to present dramatic evidence against many of the prevailing myths associated with Black students today. Echoing their sentiments, Hugh W. Lane, president of NSSFNS, hoped that publication of the study would lead to "less fear, less thinking of Black students as strange or alienated" on the part of society at large and of persons in high schools and colleges in particular. He said the study showed that "Black students are just students, like everybody else."[57]

The characteristics and attitudes revealed by the NSSFNS study indicate that there is a large pool of college-bound, well-educated, highly motivated Black students, perhaps unsure of themselves intellectually but willing to work hard, within "the system," to build better lives for themselves and their disadvantaged brothers and sisters.

An engineering profession truly committed to these same humane objectives should have little difficulty attracting substantial numbers of Black youth into engineering careers. The challenge to engineering educators and employers will be to demonstrate these shared concerns and to ensure that those students who do pursue engineering careers are handled responsibly and do find engineering the rewarding profession we hold it to be.

As we pointed out earlier, the 1974 report by NSSFNS on the Black high school classes of 1972 and 1973 does not contain the same attitudinal data as does the 1971 report, but it does contain some academic and vocational data useful for our assessment of minority interest in engineering. The 1974 report indicated that 64% of the students surveyed ranked in the top third of their classes, with 38% in the top quarter, and that 58% of them had pursued an academic as opposed to a vocational course of study. More than 16% had an average of B-plus or better, more than 73% had taken a laboratory science course, and almost half had taken three or more years of natural science courses. About 50% of the students expected to have taken at least three years of mathematics by graduation and 37% of them had mathematics grade point averages of B or better. The proportion of students rating themselves as intellectually "much better than average" increased from 37% in 1972 to 44% in 1973.

The percentage of Black high school seniors aspiring to complete at least a

bachelor's degree in college rose from 82% in 1972 to 88% in 1973 and about half of each class indicated that they would seek a degree beyond the bachelor's level. Only 5.8% of the 1972 class—14.1% of the males and 0.4% of the females—indicated engineering as their probable major field of study in college. These numbers changed to 5.2%—12.0% of the males and 1.0% of the females—for the class of 1973 and reflect the declining interest in engineering of most high school students during that period.

The percentage of Black students planning to major in "mathematics or statistics," "physical sciences," and "other technical fields" changed from 3.0%, 1.2% and 3.0% respectively in 1972 to 2.1%, 0.9% and 3.8% in 1973. Along with the students who indicated "engineering," these students constituted total engineering and science pools of 13.0% and 12.0% respectively, of the 1972 and 1973 classes who might be considered as potential engineering college freshmen the following autumns. For ease of reference, Table 3-14 summarizes the engineering-related findings of the three NSSFNS surveys of Black college-bound youth.

From Table 3-14 it seems clear that the total technical pool of Black high school seniors has remained relatively constant over the three year period but that engineering has been losing out as an intended major within that pool to other technical pools. Note also in Table 3-14 that Black women continue to outnumber Black men in the college-bound pool.

TABLE 3-14

Changing Interest of Black Twelfth-Graders in Engineering

	TOTAL			MALE			FEMALE		
	1971	1972	1973	1971	1972	1973	1971	1972	1973
Number of students in sample (in thousands)	54.4	41.3	38.1	22.2	16.5	14.8	32.2	24.8	23.3
Percentage of students aspiring to at least a bachelor's degree	85.0	81.6	86.5	86.5	83.9	88.2	84.1	80.1	85.4
Percentage of students planning to major in:									
(a) Engineering	6.2	5.8	5.2	14.6	14.1	12.0	0.6	0.4	1.0
(b) Math & Statistics	3.0	3.0	2.1	3.2	3.5	2.3	2.8	2.6	2.0
(c) Physical Science	1.3	1.2	0.9	2.3	2.0	1.4	0.7	0.7	0.5
(d) Other Technical	2.8	3.0	3.8	5.8	6.3	6.9	0.8	0.8	1.8
(e) Total Technical Pool	13.3	13.0	12.0	25.9	25.9	22.6	4.9	4.5	5.3
(f) Business	20.7	20.5	18.3	17.4	15.8	16.1	22.9	23.6	19.8
(g) Education	10.6	10.5	8.7	9.1	10.6	8.5	11.7	10.5	8.8
(h) Pre-Professional	7.0	8.6	11.5	9.5	11.5	14.4	5.3	6.7	9.6

To provide a better understanding of minority high school youth and their preparation for possible engineering study in college, it would be extremely valuable if NSSFNS could expand its high school surveys to include the non-Black minorities, and perhaps a white control group, as well as its current Black constituency.

While the NSSFNS surveys have not been utilized in this fashion so far, it appears to the Task Force that it would be useful to do a computer analysis of their data on the subpopulation of minority high school students who indicated engineering as their probable major in college. By making one computer run and printing out the survey responses of just these "engineering" students, and possibly those indicating "mathematics," "physical sciences" and "other technical fields" as intended majors as well, it would be possible to develop valuable insights concerning the academic preparation, attitudes and motivation of those Black high school students who are presently attracted to engineering.

Minority Participation in Engineering

To see what happens to the college-bound minority students, the Task Force turned next to the important ACE study by Bayer[58] of the Black college freshmen who enrolled in the fall of 1971. This study, following the usual ACE methodolodgy, derived national norms for the subpopulation of Black full-time first-time freshmen surveyed in their regular autumn (CIRP) survey of all college freshmen. This survey is especially useful in that it affords us a follow-up glimpse of those high school seniors NSSFNS surveyed earlier in 1971.

According to Bayer, of the estimated 97,684 Black college freshmen in 1971, only 4.9% indicated probable majors in engineering. Only 9.8% of the Black males and 0.4% of the Black females planned to major in engineering. Recalling that, when polled by NSSFNS in the last year of high school, this same class of Black students indicated 6.2% (14.6% of the males and 3.2% of the females) planning to major in engineering in college, we see that Blacks, as well as whites, become significantly less interested in engineering during the brief period between the twelfth grade and enrollment in college. Some observers believe this is largely due to the lack of interest by engineering colleges in recruiting these students because of the large amounts of financial aid they require.[59]

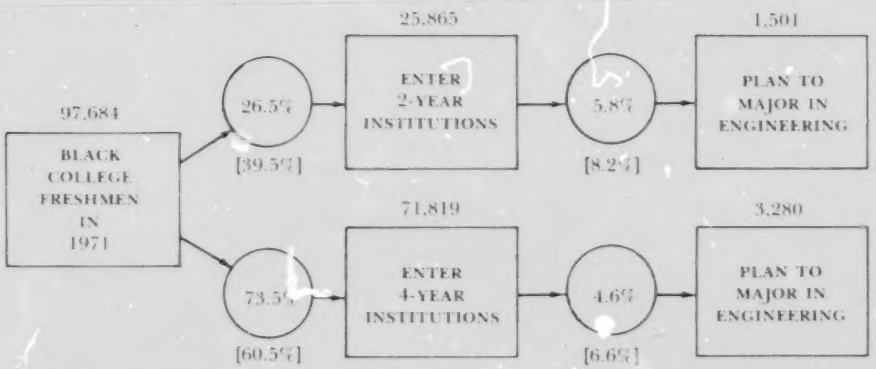
If we add to the Black engineering majors those freshmen who planned to major in mathematics or statistics, physical sciences, and other technical fields, and again interpret this as the total possible technical college pool out of which engineers might have been recruited, we end up with a figure of 12.0% for the Black 1971 college freshmen available for engineering study. This 12% college figure holds up quite well when compared to the 13.3% we considered as potential engineers in high school earlier that year (NSSFNS). The interpretation is clear: the total Black technical pool remains relatively constant between high school and college, but engineering as a chosen major is losing out within that pool. **It certainly seems important to the Task Force that engineering educators and professionals devote some of their resources to stemming this**

flow of qualified students away from engineering into other technical fields.

Just as we found it convenient in Figures 3-1, 3-2, and 3-3 to draw block diagrams to show how freshmen of all races flowed into engineering majors, it is useful to display the enrollment patterns of the Black college freshmen in a flow chart format. In Figure 3-5 we show the two-year versus four-year entry patterns of 1971 Black freshmen. For ease of comparison with Figure 3-2 which shows the total flow in 1973, and with Table 3-8, we have printed the corresponding percentages of the total [all races] freshman class of 1971 in square brackets beneath each circle containing the percentage of Black students proceeding along a given pathway.

FIGURE 3-5

Flow Patterns of 1971 Black Freshmen into Engineering



Since the data on the 1971 Black freshmen is tabulated by sex and type of college, it is quite revealing to draw in Figure 3-6 a block diagram which reveals the breakdown by sex and Black college versus white college of the flow of Black freshmen into engineering majors.

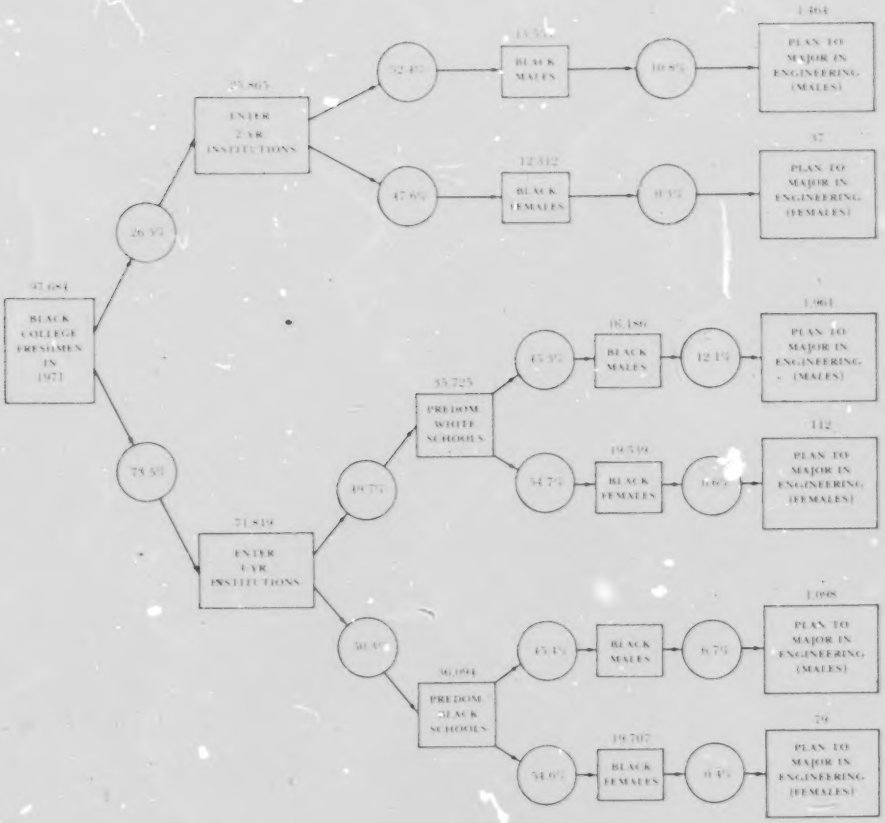
In Figure 3-6 we have not bothered to break the two-year institution pathway down into Black versus white colleges since there are few traditionally Black-controlled junior colleges and almost all Black students enrolled in junior colleges are in predominantly white public institutions.

Two things about the 1971 Black freshmen stand out quite clearly in the flow chart of Figure 3-6:

1. The predominantly Black colleges enroll about as many Black students as do the predominantly white four-year schools.
2. Black females in all types of schools are essentially not participating in engineering at all.

FIGURE 3-6

Male and Female 1971 Black Freshmen Majoring in Engineering in Predominantly Black and Predominantly White Colleges



We should point out that the reason it may appear in Figure 3-6 that there is less interest in engineering among the Black males in Black schools (6.7%) than among the Black males in white schools (12.1%) is that there are only six Black engineering colleges and almost three hundred white engineering colleges.

Since there are about equal numbers of males and females in all types of institutions, and, since girls are often better students in high school than boys, it seems obvious to the Task Force that **the most readily available pool of additional potential minority engineering students is the present class of Black college-bound women.** With a sensitivity to the historical concerns of many

Blacks about the problems of a "matriarchal society," engineering educators and professionals ought to develop guidance and recruiting efforts specifically aimed at minority females and to work closely with other affirmative action and women's rights groups to make sure that they are aware of the special opportunities in engineering.

In that same 1971 survey of Black freshmen, Bayer identified several other minority groups but because of the unrepresentativeness of their institutional enrollments he was unable to apply institutional weights to derive national norms for these groups. He did, however, publish the unweighted responses of the actual subsamples of 1,218 Chicano, 465 Puerto Rican, 1,261 American Indian and 1,209 Oriental college freshmen. This is the only survey, however small, which we have found which contains attitudinal and engineering specific enrollment data for Chicanos, Puerto Ricans, American Indians and Orientals. Accordingly, having acknowledged Bayer's caveats, we display in Table 3-15 the relative interests of these 1971 freshmen in engineering. We include the Orientals and total college freshmen of all races for ease of comparison and to demonstrate once again that Oriental Americans are participating more than adequately in engineering education and do not need any extra encouragement to continue to do so.

As Table 3-15 shows, even for this small sample, there are significant differences between the interests of the four underrepresented minorities in engineering. The Puerto Ricans and American Indians appear to have slightly greater interest in engineering than the freshman class as a whole; the Chicanos have only slightly less interest; and the Blacks stand out dramatically as not being attracted into engineering programs.

TABLE 3-15

A Comparison of 1971 Minority Freshmen Majoring in Engineering

RACIAL OR ETHNIC BACKGROUND	NUMBER IN SAMPLE	ACE* ESTIMATE US TOTAL NUMBER OF FRESHMEN	PERCENTAGE PLANNING TO MAJOR IN ENGRG.	PERCENTAGE HAVING HS AVERAGE OF B OR BETTER	PERCENTAGE FEELING NEED FOR SPEC. HELP IN MATH	PERCENTAGE RATING SELF BETTER THAN AVERAGE IN ACAD. ABILITY
Black	13,509	102,951	4.3	48.9	55.6	32.5
Chicano	1,218	17,975	6.8	54.2	47.2	38.5
Puerto Rican	465	3,268	7.9	68.0	48.6	36.9
American Indian	1,642	14,707	8.6	48.6	52.4	33.6
Oriental	1,209	8,170	17.2	81.0	25.1	70.3
Total, All Races	171,509	1,634,154	7.2	57.4	36.0	50.6

*The estimates of the actual number of full-time college freshmen of each racial or ethnic group are taken from the ACE report, *The American Freshman: National Norms for Fall 1971;* Reference 18.

These results are consistent with the generally prevailing beliefs that the profession of engineer or builder has long been highly regarded by Hispanic peoples and that American Indians concerned with land management, forestry, water, housing, sanitation, mining, roads and construction are increasingly aware of engineering as a problem-solving discipline.

This indicates to the Task Force that **while Blacks are increasingly college-bound, they are being under-recruited into engineering. In contrast, the other minority groups have sufficient interest in engineering among the small numbers who are presently college-bound, so that efforts to increase their numbers in engineering must be addressed to increasing their elementary and high school progress in pre-college programs.**

The last three columns of Table 3-15 indicate that those underrepresented minorities in college, who on the strength of their high school grades, seemed adequately prepared for college work, perceived themselves as only having average academic ability and in need of special help in mathematics. This leads the Task Force to conclude that **engineering educators and professionals interested in increasing minority progress in engineering must make special efforts to provide remedial and tutorial assistance and personalized academic advising to overcome actual and perceived deficiencies in minority students' backgrounds.**

Just as was recommended for the NSSFNS survey, the Task Force believes it would be extremely useful to have a special computer analysis done on those minority and majority college freshmen who indicated an interest in engineering or related fields in the Bayer study and in the ACE freshmen surveys. It would be of obvious value for engineering educators to know the enrollment patterns, high school grades, academic self-ratings, perceptions of need for special help in mathematics and English, and financial need and other motivational data specifically for minority engineering freshmen to plan effective advising and supportive programs.

Some readers may have noted in Figure 3-5 that Blacks in 1971 were not enrolling in two-year schools as heavily as other students. This condition is no longer the case and, as we show in Table 3-16 from the ACE freshmen surveys[60] of 1971, 1972, and 1973, Blacks are now entering two-year colleges in about the same proportions as the total student population.

It is clear from Table 3-16 that for Blacks and whites there is about a 40-60 split in enrollments between two-year and four-year colleges and that this split may be heading for a 45-55 split in the future. For the Chicanos, however, the split is more like 75-25 between two-and four-year colleges.

For a final measure of minority enrollments in engineering, the Task Force turned to the engineering enrollment and degree data gathered by Engineering Manpower Commission which since 1969 has been attempting to report Black enrollments by class year along with total enrollments in engineering schools. Starting in 1973, EMC has also begun to report "Spanish-surnamed" and American Indian enrollments and degrees in engineering colleges. The Black engineering school enrollment data are collected in Table 3-17.

There is again a temptation for some investigators desperate to understand

TABLE 3-16

Changing Minority Freshmen Enrollment Patterns

MINORITY OR ETHNIC BACKGROUND	1971	1972	1973
	PERCENTAGE OF STUDENTS		
Black			
2-yr. schools	23.7	39.0	43.8
4-yr. schools	*70.3*	*61.0*	*56.2*
Chicano			
2-yr. schools	80.9	82.8	76.9
4-yr. schools	*19.1*	*17.2*	*23.1*
Puerto Rican			
2-yr. schools	20.0	33.5	56.4
4-yr. schools	*80.0*	*66.5*	*43.6*
American Indian			
2-yr. schools	41.0	44.5	37.6
4-yr. schools	*59.0*	*55.5*	*62.4*
Oriental			
2-yr. schools	26.1	52.7	57.2
4-yr. schools	*73.9*	*47.3*	*42.8*
Whites			
2-yr. schools	39.6	37.9	39.7
4-yr. schools	*60.4*	*62.1*	*60.3*
Total, all races			
2-yr. schools	39.5	39.0	40.9
4-yr. schools	*60.5*	*61.0*	*59.1*

something about minority retention patterns to misuse the data in Table 3-17 and try to interpret year-by-year enrollment ratios as measures of retention. Our warnings about similar attempts on the data in Table 3-11 apply even more strongly here with the Black enrollment figures because, as we saw in Table 3-13 on the California minority engineers and in Table 3-16, so many minority engineering students are transfer students who enter engineering colleges at various class levels.

In the past five years, almost 66% of all engineering bachelor's degrees earned by Blacks have been produced by just 25 engineering colleges with the six

TABLE 3-17

Black Full-time Engineering College Enrollments

	1969	1970	1971	1972	1973
Freshmen	977	1,424	1,289	1,477	1,684
Sophomores	704	811	926	965	950
Juniors	430	664	693	838	784
Seniors	397	575	588	661	671
Fifth Year	25	24	26	34	42
Total Undergraduate	2,757	3,753	4,136	4,356	4,869
M.S. *Full Time*	55	106	112	165	221
Part Time	*84*	*109*	*140*	*172*	*157*
Ph.D. *Full Time*	22	44	44	49	38
Part Time	*4*	*8*	*13*	*9*	*15*
Grad. *Full Time*	81	171	192	238	272
Part Time	*88*	*119*	*154*	*181*	*183*

predominantly Black schools (Prairie View A & M, Howard, Southern, North Carolina A & T, Tennessee State and Tuskegee) accounting for 47% of the total number. Engineering degrees awarded to Blacks for the last five years are shown in Table 3-18. These have been ordered by total baccalaureate degrees awarded by individual schools for the entire time period 1968–73; rather than picking a single year, which may be unrepresentative.

The main criterion considered when making up Table 3-18 was whether a school had awarded more than five engineering degrees to Blacks in *either* 1971–72 *or* 1972–73, and the top twenty-five were listed. These schools have awarded between 57% and 75% of the total engineering degrees given to Blacks in these five years.

The 25 leading engineering schools in Black undergraduate engineering enrollments are shown in Table 3-19. Because enrollment data are notoriously less reliable than degree data,[61] and particularly because Blacks were only just beginning to be counted by EMC in Fall 1969, the criterion used in compiling Table 3-19 was largest combined Black engineering enrollment for the three-year period 1971–1973. In addition to the schools shown in Table 3-18 as the large producers of Black BS engineers, Table 3-19 gives an indication of some engineering schools which are up-and-coming in this area; 10 of the 25 schools in Table 3-19 do not appear in Table 3-18. These 25 schools account for between 62% and 68% of all Black engineering enrollments in the period 1969–1973. While enrollments in the predominantly Black schools have declined as percentages of Blacks enrolled in engineering (51% in 1969, 40% in 1971, 34% in 1972,

TABLE 3-18

Estimate of B.S. Degrees in Engineering Earned by U. S. Blacks

	1972-73	1971-72	1970-71	1969-70	1968-69	TOTAL 1968-73
Prairie View	55	67	71	55	49	297
Howard U.	35	48	58	37e	42	220
Southern U.	46	33	22	54	28	183
North Car. A & T	32	25	39	28	32	156
Tennessee St.	29	20	24	39	30	142
Tuskegee	24	29	15	20	8	96
C.C.-C.U.N.Y.	20e	25e	25e	NA	NA	70
Chicago Tech.	22	10	14	0	0	55
Purdue	9	7	5	6	7e	34
Tufts	1e	9	0	20	0	30
Hampton	16	10	0	0	0	26
Drexel	8e	5e	5	7	1	26
Newark C.	8e	6	8	3e	0	25
PINY	9e	8	0	7	0	24
U.C. Berkeley	7	5	4	3	1	20
M.I.T.	9e	3e	4	NA	0	16
U. Ill.-Chic.	10e	5e	0	0	0	15
U. Md.	3	8	3	0	0	14
Heald Eng. C.	8	5e	0	0	0	13
U. Ill (Urb.)	8	2	3	0	0	13
Princeton	6	5	0	0	1	12
Wash. U. (St. L)	6	2	1	2	0	11
U. Arkansas	0	6	0	1	2	9
Union College	0	7	0	1	0	8
Stanford	6	0	0	NA	1e	7
Total this Page	377	359	301	283	202	1522
Total to Blacks	657	579	407	378	314	2535
% this Page/ Black Total	57.4	62.0	74.0	74.9	64.3	65.2

e = estimate, NA = not available

SOURCE: *Engineering and Technology Degrees*, annual report of EMC.

TABLE 3-19

Estimated Black Undergraduate Engineering Enrollments

	1973	1972	1971	1970	1969	1971 + '72 + '73
Prairie View	332	313	350		349	995
NC A & T	*2* 279	*13* 284	*7* 330		*15* 375	*22* 893
Howard Univ.	*13* 261	*37* 228	*16* 358			*66* 847
Tuskegee	242	250	222		202	714
Southern U.	200	216	221		196	637
CCNY	*106* 165	*125* 185	*110* 240		0	*335* 590
Tennessee St.	217	196	159		287	572
Newark Coll.	149	*50* 130	*30* 120			*880* 399
U. Ill.–Chic.	133	122	44	NOT	50	299
Drexel	*36* 51	*40* 126	*40* 115	PUB-	*48* 92	*116* 292
Genl. Motors In.	136	94	46	LISHED		276
Mich. St. U.	82	93	83	FOR	68	258
Cornell	96	90	60	BLACKS	34	246
Ohio State	65	80	62	OTHER	50	207
Purdue	*6* 79	66	60	THAN	60	*6* 205
Northwestern	54	52	50	AS		156
Pratt Inst.	37	*10* 58	50	TOTAL		*10* 145
Rensselaer	48	34	57			139
U. Houston	*20* 54	*20* 42	*20* 42		*18* 38	*60* 138
MIT	56	56	4		3	116
Chic. Tech	57	*35* 59				116
NC St. U.	*2* 38	*2* 43	*1* 33			5 114
U. Ill.–Urb.	58	54				112
Cal. St.–LA	79	*49* 7	*13* 18		*19* 19	*62* 104
Heald	40	61				101
TOTAL THIS PAGE	3008	2939	2724		1823	8671
TOT. BLACK ENROLLMENT	4869	4356	4136	3753	2757	13361
% THIS PAGE/ BLACK EN- ROLLMENT	61.7%	67.5%	65.9%		66.1%	64.9%

SOURCE: *Engineering and Technology Enrollments*, annual report of Engineering Manpower Commission. Part-time enrollments are shown in italics.

31% in 1973), the six southern Black schools still account for nearly a third of the Black engineering enrollments.

It is important to note that the list in Table 3-19 does not include any of the more than 15 predominantly Black non-engineering colleges which participate in dual-degree or 3-2 programs with engineering colleges and enroll substantial numbers of Black engineering students. For example, the four Black liberal arts colleges of the Atlanta University Center-Georgia Tech Dual Degree Program have 230 Black engineering majors now enrolled at various levels and should continue to be an important producer of Black engineers.

Because of the unique role the six predominantly Black engineering colleges have played in producing Black engineering graduates, they represent a significant resource for increasing minority participation in engineering. They have been underfunded and underutilized, and their expansion and improvement will depend upon broadly based, long-term support from government, industry, and foundations. **The Task Force recommends that the six Black**

TABLE 3-20

Estimate of B.S. Degrees in Engineering Earned by Spanish-surnamed Students, 1973

INSTITUTION	DEGREES
University of Texas—El Paso	50
New Mexico State University	42
Texas Agric. & Indus. Univ.	26
California St. U., Los Angeles	22
City College of CUNY	20
Chicago Technical College	18
University of New Mexico	17
University of Southern Florida	15
Florida Atlantic University	10
Heald Engineering College	10
University of Arizona	8
Louisiana St. U., Baton Rouge	8
Calif. St. U., San Jose	7
Polytechnic Institute of N. Y.	6
Total, Top 15 Producers	259
All Other Engineering Schools	462
Total, All Engineering Schools	721

SOURCE: *Engineering and Technology Graduates, 1973* (New York: Engineering Manpower Comission), Table 24, pp. 45–49.

engineering colleges be supported at sufficient levels to increase their present minority enrollments by at least 100% over the next five-years.

Regrettably, there are few data available on the numbers of Chicanos, Puerto Ricans or American Indians enrolled in or receiving degrees from engineering schools. However, starting in 1973 the Engineering Manpower Commission began collecting and publishing enrollments and degrees earned by Spanish-surnamed and American Indian students. While the Spanish-surnamed figures include Cubans, South and Central Americans and other Spanish groups which are amply represented in engineering, they are at present the only clues to Chicano and Puerto Rican enrollments. Table 3-20 lists the top fifteen schools for 1973 in the production of Spanish-surnamed engineering bachelor's degrees.

The total Spanish-surnamed engineering enrollments for 1973–1974 are shown by class level in Table 3-21.

The Task Force emphasizes, once again, that the enrollments and degree figures reported by EMC and displayed in Tables 3-20 and 3-21 be used with great caution in making inferences about the participation of Chicanos and Puerto Ricans in engineering. No experienced observer of affirmative action programs would believe that very many of the 721 bachelor's degrees reported

TABLE 3-21

Spanish-surnamed Full-time Engineering College Enrollment 1973-1974

Freshmen		525
Sophomores		397
Juniors		421
Seniors		407
Fifth Year		21
Total Undergraduate		2,371
M.S.	*Full-time*	153
	Part-time	*123*
Ph.D.	*Full-time*	24
	Part-time	*5*
Total Graduate	*Full-time*	193
	Part-time	*134*

SOURCE: *Engineering and Technology Enrollments, Fall 1973* (New York: Engineering Manpower Commission, April 1974), p. 69.

by EMC (Table 3-20) to have been awarded to Spanish-surnamed students in 1973 were earned by Chicanos or Puerto Ricans. For example, in a check of Spanish-surnamed petroleum engineering graduates in one of the southwest engineering schools listed in Table 3-20, of the four students listed, not one was a Chicano-Mexican American or Puerto Rican.[62] One Chicano research group, the Personnel Management Association of Aztlan (PMAA), estimated that in 1972 only 205 Chicanos graduated in engineering out of 1,725 Chicano graduates in all fields.[63] John Alden of EMC estimates that 45% of the Spanish-surnamed engineers in the U. S. are immigrants from Cuba, Argentina, Colombia and other Spanish-speaking countries and concludes that ". . . possession of a Spanish-sounding name or a speaking knowledge of Spanish is a rather poor criterion for compiling minority statistics."[64]

In Table 3-22 we list the EMC estimate of engineering bachelor's degrees earned by American Indians in 1973.

TABLE 3-22

Estimate of Engineering B.S. Degrees Earned by American Indians, 1973

Michigan Tech. University	14
Cooper Union (New York)	5
Oklahoma State University	3
Western States College of Engineering (California)	3
General Motors Institute	2
Lehigh University (Pennsylvania)	1
Le Tourneau College (Texas)	1
Penn. State	1
U. S. Merchant Marine Academy	1
University of Nevada—Reno	1
University of New Hampshire	1
University of Oklahoma	1
University of Tulsa	1
University of Washington	1
	36

SOURCE: *Engineering and Technology Graduates 1973*, (New York: Engineering Manpower Commission, Table 24, pp. 45–49).

In Tables 3-23 and 3-24 we show respectively the total U. S. American Indian engineering enrollments and the seventeen leading engineering colleges in Indian enrollments for the academic year 1973–74.

TABLE 3-23

American Indian Full-time Engineering College Enrollment, 1973-1974

Freshmen		40
Sophomores		39
Juniors		41
Seniors		46
Fifth year		2
Total Undergraduate		204
M.S.	*Full-time*	18
	Part-time	6
Ph.D.	*Full-time*	3
	Part-time	14
Total Graduate	*Full-time*	23
	Part-time	22

SOURCE: *Engineering and Technology Enrollments, Fall 1973* (New York: Engineering Manpower Commission, April 1974), p. 73.

Since the purpose of requesting racial and ethnic information from engineering schools is to monitor the progress of underrepresented minorities, **the Task Force believes that EMC should begin to specifically request enrollment and degree data for Chicanos, Puerto Ricans and American Indians, as well as for U. S. Blacks and women.** All engineering colleges should, by now, be able to count their own students in inoffensive, reliable ways and to report this data in a timely competent fashion to EMC.

In Appendix B we present the results of an informal Task Force survey of 35 institutions which today are producing more than 60% of the Black engineering graduates in the country. These institutions include thirteen of those predominantly Black four year colleges which do not offer degrees in engineering but instead participate in Dual Degree or 3–2 programs with accredited engineering colleges and are today contributing substantially to the production of minority engineers.

Having concluded this brief analysis of engineering education and of the interest and inadequate enrollment levels of minorities in engineering, we are ready for the next chapter which articulates reasonable schedules for increasing enrollments to equitable levels within the next decade.

TABLE 3-24

American Indian Enrollments at Accredited Engineering Schools, 1973-1974

Top 17 Schools

Michigan Tech U	25
Oklahoma State U	14
University of Houston	13
U of Kentucky Louisiana	11
General Motors Institute	9
Cal State U San Jose	7
Cal State Poly Pomona	6
Cal State U Long Beach	6
Cal State U Los Angeles	5
U of New Mexico	5
U of Washington	5
U of Colorado	4
Fairleigh Dickinson U	4
Louisiana Tech U	4
U of Oklahoma	4
U of Texas-Arlington	4
U of Utah	4

SOURCE: *Engineering and Technology Enrollments–Fall 1973* (New York: Engineering Manpower Commission, April 1974), pp. 72–73.

4

Educational Goals and Measures of Progress

This report is directed at the needs of four ethnic and racial minorities: Blacks, Chicanos (Mexican Americans), Puerto Ricans, and American Indians (Native Americans), who are underrepresented in the profession of engineering in the United States. The Task Force believes that an effort should be made to improve their representation until parity is achieved. Since an engineering education is essential for practically all individuals who succeed in the profession, the effort should be directed at enabling and encouraging more minority members to gain such an education. As a major step toward bringing this about, **the Task Force proposes a basic goal: Equality in rates and patterns of enrollment and retention for minority men and women being educated as engineers.**[1]

The Task Force believes that social justice demands that minority students be represented in engineering education in the same proportion that they are represented in the U. S. population of comparable age. This chapter will define percentage goals which, if achieved on schedule, would produce parity in the freshman class of engineering schools by 1982, and within the entire undergraduate student body of these schools by 1987 (since it takes a majority of engineering students almost five years to get the B.S. degree). This is a vital first step toward the proper representation of minorities in the profession. Unfortunately, it will take a generation after that, with sustained education of a proportionate share of minority students for two decades or more, before equality can be achieved throughout the profession.

PERCENTAGE REPRESENTATION IN ENGINEERING SCHOOLS

What is a fair percentage if minority students are to be equitably represented in engineering schools? Data from the 1970 U. S. Census for boys and girls aged 8–14, those who will be about college age in 1980, show that the four underrepresented minorities make up about 18% of the total age group (Table

4-1). Accordingly, **the Task Force recommends as a national target that 18% of all undergraduate enrollment be devoted to these minorities.** This target will need to be adjusted for local differences (in some cities Blacks and Puerto Ricans will be represented more heavily than 18% for instance, while southwestern schools will provide a proportionately larger number of spaces for Chicano students), but it is a realistic nationwide goal.

This percentage will be used as the basis for developing specific year-by-year targets for engineering schools. A correspondingly detailed plan should also be developed for engineering students who begin their higher education in two-year colleges or in four-year institutions having no engineering curriculum but because of the almost complete lack of enrollment data and monitoring mechanisms for these institutions, no year-by-year targets are set. Instead, the Task Force recommends that engineering colleges and professionals work closely with these feeder schools to insure that minority youth are equitably represented in the pre-engineering programs as well. As a crude target for improvement, the Task Force proposes that the engineering profession strive to bring the percentages of minority youth who plan to major in engineering, as

TABLE 4-1

Percentage Representation of Four Minorities in U. S. College-Age Population 1980

MINORITY	NUMBER	PERCENTAGE OF AGE GROUP
(1)	(2)	(3)
Black	3,930,389	13.51%
Chicano	850,405	2.92%
Puerto Rican	251,239	.86%
American Indian	138,938	.48%
Total	5,170,971	17.77%

SOURCES: Col. 2 utilizes 1970 U. S. Census data for children aged 8–14 (age 18–24 in 1980). Data were obtained from two Department of Commerce Census of Population, 1970, Subject Reports. They are reports PC(2)-5A, *School Enrollment* (Black and American Indian, listed as Negro and Indian respectively) and PC(2)-1C, *Persons of Spanish Origin* (Chicano, listed as "of Mexican Origin," and Puerto Rican).

Col. 3 was calculated by dividing the numbers in Col. 2 by the total U. S. 8–14 year-old population (29,086,539) reported in *School Enrollment*, PC(2)-5A.

measured by the annual ACE freshman surveys, up to the levels of the white majority students in corresponding institutions.

FRESHMAN PARITY BY 1982

The Task Force based its planning upon a calendar covering the period 1972–1982. The first year was chosen as the base because that was when the engineering profession became sufficiently aroused by the serious shortcomings in opportunities for minorities to begin serious and widespread efforts to rectify the situation. By 1973 there was some increase in the percentage of minority freshmen, but quite obviously the 18% goal cannot be reached in two or three years, even among entering classes. It will, after all, require a substantial increase in numbers of minority students, which will in turn necessitate both a large recruiting effort and considerable improvement in the college preparation of many students.

The Task Force decided that the **18% goal could realistically be reached with the freshman class entering in 1982.** Subsequent classes will all be expected to have the proper minority representation so that by the time the entering 1982 students graduate in 1986 and 1987, the nation's engineering schools should be providing equitable educational opportunities for the four presently underrepresented minorities.

ENROLLMENT PROJECTIONS

In order to assure reasonable progress toward parity, the Task Force decided that percentage goals should be proposed for each year until 1982. This in turn required projections of both engineering school enrollments and minority student enrollments. Freshmen enrollments were chosen for these projections, for two reasons. First, freshmen enrollments can be monitored four years earlier than total enrollments, or graduates, and thus will indicate trends earlier. Second, freshmen enrollments set the pattern for the entire undergraduate program; without substantial improvement in the freshman class there will be no improvement in numbers of graduates. And since one of the goals of the Task Force recommendations is to promote comparable rates of retention, as well as admission, of minority students, it is intended that equitable proportions of minority members will be included in all classes.

Two basic projections were made. One was conservative, the other more optimistic. Both projections are discussed in the following subsections.

Conservative Projection of Freshman Engineering Enrollment

The conservative projection was based upon the latest estimates from the U. S. Office of Education's National Center for Educational Statistics (NCES).

TABLE 4-2

Derivation of Conservative Projections of Freshman Engineering School Enrollment

YEAR OF GRADUATION	ACTUAL OR NCES PROJECTED B.S. ENGINEERING DEGREES	ACTUAL OR PROJECTED FRESHMAN ENGINEERING ENROLLMENT FOUR YEARS EARLIER	RATIO OF DEGREES TO FRESHMAN ENROLLMENT (3) ÷ (2)
(1)	(2)	(3)	(4)
1962	34,551		
1963	33,285		
1964	35,013		
1965	36,586		
1966	35,615	64,707	.55
1967	35,952	65,740	.55
1968	37,368	73,682	.51
1969	41,248	79,872	.52
1970	44,479	–	–
1971	44,898	77,551	.58
1972	45,870 (est.)	77,484	.50
1973	45,510 "	74,113	.61
1974	43,090 (projected)	71,661	.60
1975	36,520 "	58,566	.62
1976	33,020 "	52,100	.63
1977	33,730 "	51,925	.65
	Task Force Projections		
1978	34,130	53,328	.64 (hypothesized)
1979	34,570	54,016	
1980	34,760	54,313	
1981	35,000	54,688	
1982	35,080	54,813	
1983	34,690	54,203	

SOURCES: Col. 2, actual and projected figures are from Table 23, *Projections of Educational Statistics to 1982-83*, U. S. Office of Education. National Center for Educational Statistics.

Col. 3, data for 1966–1969 are 1962–1965 figures from "Engineering Degrees (1964–65) and Enrollments (Fall 1965)," U. S. Office of Education, National Center for Educational Statistics. Data for 1970 (freshmen of 1966) were not available. Figures for 1971–1977 are actual enrollments for 1967–1973 from *Engineering and Technician Enrollments, 1972*, Engineering Manpower Commission.

Figures for 1978–1983 are calculated from Col. 2 using the hypothesized ratio of 0.64.

Projections of the number of B.S. degrees in engineering through 1983[2] were used to calculate the number of full-time freshmen expected to enroll in engineering schools four years earlier. This provided us with estimates of freshman engineering enrollments through the fall of 1979.

Table 4-2 shows how the freshman figures through 1979 were derived. Actual freshman enrollments between 1967 and 1973 were compared with NCES degree projections for four years later. The ratio of graduates to freshmen remained relatively constant, between 0.58 and 0.65. The mean of the ratio for the last two years, 0.64, was arbitrarily selected as a constant conversion factor to use in projecting future engineering degrees from freshman enrollments. The NCES projections for 1978–1983 graduates were then divided by the factor 0.64 to give our projection for freshmen for 1974–1979 (Col. 3, Table 4-2).

Because the NCES degree projections stopped at 1983, the freshman projections could only be carried to 1979 by the previous method. In order to calculate freshmen for 1980–1982, freshman engineering enrollments were examined in relation to total college freshman enrollments. As Column 6 of Table 4-3 shows, the percentage of college freshmen enrolled in engineering is projected to remain comparatively constant (between 3.8% and 4%) between 1974 and 1979, using the NCES projections and our engineering freshmen calculations from Table 4-2. Because this percentage rose from 3.9% to 4.0% from 1978 to 1979, we assumed it continued to increase at the rate of 0.1% per year for 1980–1982. The resulting percentages, 4.1, 4.2, and 4.3%, multiplied by NCES projections of all college freshmen, produced the needed engineering freshmen numbers for the remaining years 1980, 1981 and 1982 to complete column 5 of Table 4-3.

In this manner we arrived at our conservative projection of engineering freshmen for the next eight years. The Task Force believes this is truly a "conservative" approach since NCES based its estimates of future B.S. degrees in engineering on present trends, and they represent very modest growth over the 1973 total (a maximum of 6.4% by 1982). These conservative enrollment figures are used in our conservative minority enrollment timetable shown later in this chapter (Table 4-6).

Optimistic Projection of Freshman Engineering Enrollment

The optimistic projection was arrived at by an entirely different approach. *The Manpower Report of the President,*[3] delivered to Congress in March 1972, predicted that there would be an average demand for 48,000 engineering graduates each year to meet the nation's manpower needs between 1972 and 1980. The latest official estimate of the U. S. need for engineers, contained in the 1974–75 edition of the U. S. Labor Department's *Occupational Outlook Handbook,*[4] predicts annual openings averaging 53,000 a year through the mid-1980's. Assuming that approximately 10% of the openings may be filled by

TABLE 4-3

High School Graduates, College Enrollment, and Engineering Enrollment

YEAR	HIGH-SCHOOL GRADUATES	FIRST-TIME COLLEGE ENROLLMENT THAT FALL (FULL-TIME)	% HIGH SCHOOL GRADUATES ENTERING COLLEGE FULL-TIME	FULL-TIME ENGINEERING FRESHMAN ENROLLMENT	% COLLEGE FRESHMEN MAJORING IN ENGINEERING
(1)	(2)	(3)	(4)	(5)	(6)
1962	1,925,000	849,000	44%	64,707	7.6%
1963	1,950,000	864,000	44%	65,749	7.6%
1964	2,290,000	1,014,000	44%	73,682	7.3%
1965	2,665,000	1,192,000	45%	79,872	6.7%
1966	2,672,000	1,140,000	43%	–	–
1967	2,679,000	1,182,000	44%	77,551	6.6%
1968	2,702,000	1,328,329	49%	77,484	5.8%
1969	2,829,000	1,404,508	50%	74,113	5.3%
1970	2,896,000	1,426,488	49%	71,661	5.0%
1971	2,943,000	1,411,032	48%	58,566	4.2%
1972	3,015,000	1,369,316	45%	52,100	3.8%
1973	3,041,000 (preliminary figure)	1,386,000 (projected)	46%	51,925	3.7%

			Future Projections		
1974	3,130,000	1,401,000	45%	53,328	3.8%
1975	3,162,000	1,406,000	44%	54,016	3.8%
1976	3,175,000	1,403,000	44%	54,313	3.9%
1977	3,199,000	1,407,000	44%	54,688	3.9%
1978	3,183,000	1,394,000	44%	54,813	3.9%
1979	3,139,000	1,362,000	43%	54,203	4.0%
1980	3,096,000	1,341,000	43%	54,981	4.1%
1981	3,052,000	1,315,000	43%	55,230	4.2%
1982	2,960,000	1,267,000	43%	54,481	4.3%

SOURCES: Cols. 2 and 3 are from *Projection of Educational Statistics in 1982–83*, U. S. Office of Education, National Center for Educational Statistics, Tables 20 (high school graduates) and 14 (first-time college enrollment).

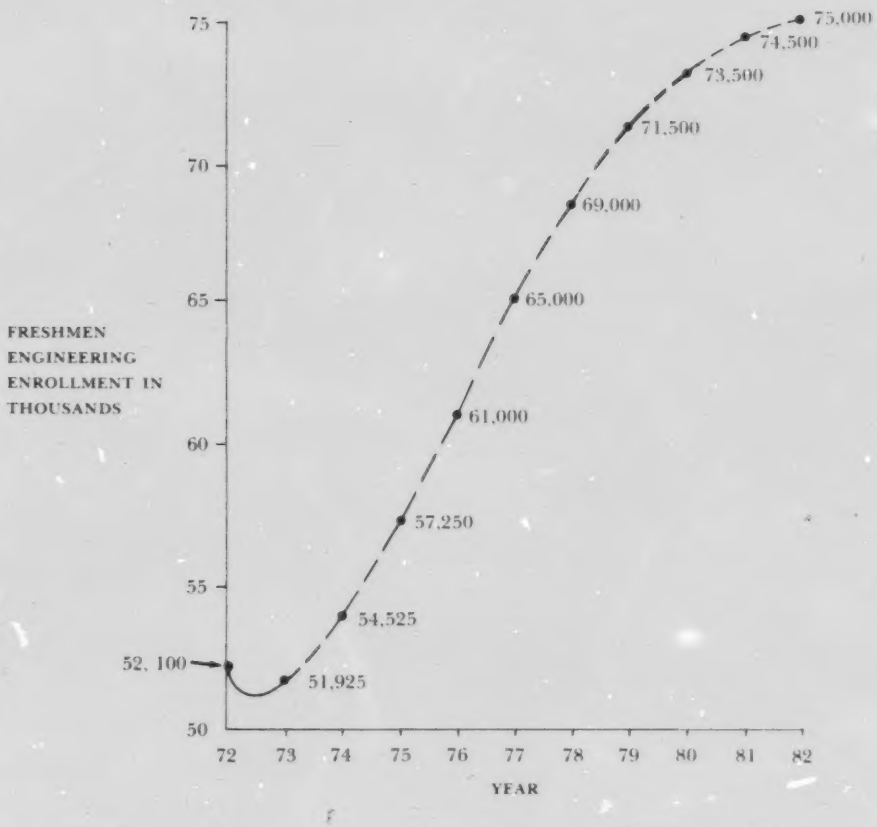
Col. 5 was developed three ways: For 1962–1965, data came from *Engineering Degrees (1964–65) and Enrollments (Fall 1965)*, U. S. Office of Education, National Center for Educational Statistics, April 1967. For 1967–79, numbers are from Table 4-2 column 3. Figures for 1980–83 were calculated by letting the percentage in column 6 rise 0.1% each year after 1979. Data for col. 5, 1966, were not available.

other than engineering graduates, this fits the earlier estimate of 48,000 annual graduates quite well.

Converted to freshmen by the formula of Table 4-2, 48,000 graduates would represent 75,000 freshmen per year (48,000 ÷ 0.64 = 75,000). American engineering schools are not enrolling 75,000 freshmen annually today, however. In 1972 and 1973 the entering classes numbered only about 52,000 students. Accordingly, it would take a period of sustained growth to reach 75,000 freshmen by the target year of 1982. An appropriate pattern of growth might follow an S-shaped growth or standard "logistic" curve, as shown in Fig. 4-1. The numbers shown later in this chapter for the optimistic projection of minority engineering freshmen growth (Table 4-7) are taken from Fig. 4-1.

FIGURE 4-1

Optimistic Logistic Growth in Engineering Freshman Enrollment to 75,000 Freshmen in 1982



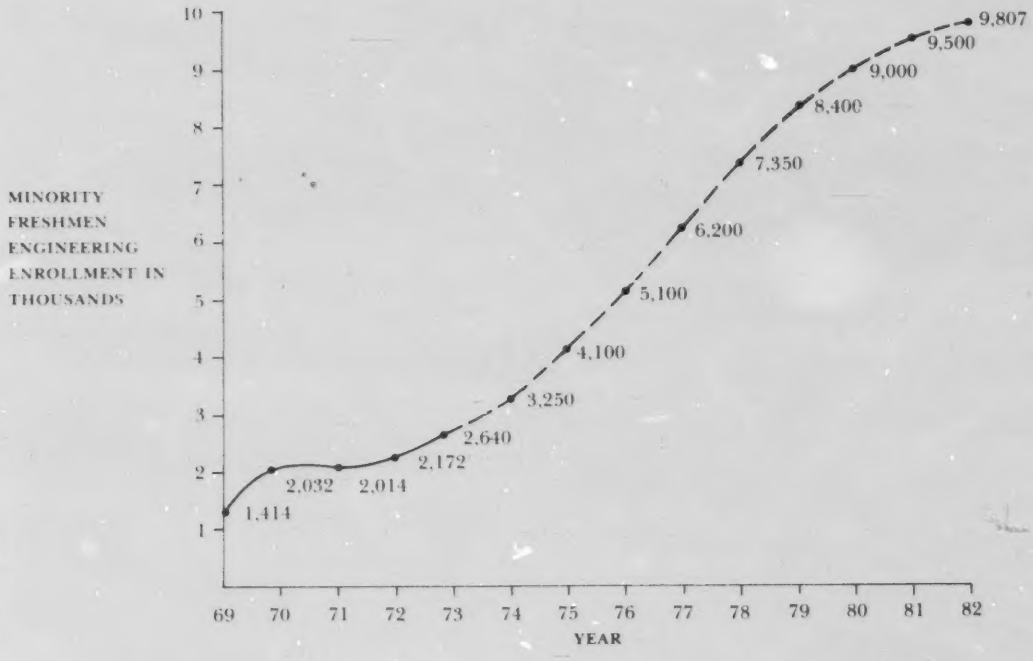
Some may feel that this projection is not optimistic enough. After all, it took only four years for freshmen enrollment to drop from 77,484 to 52,100 after the cutbacks in the space and defense programs early in this decade, but our curve in Fig. 4-1 takes nine years to reach 75,000 again. Furthermore, a poll of the deans of 140 engineering schools in the spring of 1974 suggested freshman enrollment might actually go up 10% in the class entering that fall based on numbers of applications received.[5] We draw our curve based on only a 5% increase between 1973 and 1974, however. And yet to the Task Force the growth represented by Fig. 4-1 seemed reasonable, and far more optimistic than the NCES projections.

Projections of Minority Freshman Engineering Enrollment

According to social scientists,[6] when diffusion of innovation can be measured it tends to follow an S-shaped standard growth curve described by the logistic function. In the beginning there is a certain social momentum to overcome so that little change occurs initially. Then activity increases and the

FIGURE 4-2

Conservative Logistic Growth to 9,807 Minority Engineering Freshmen in 1982

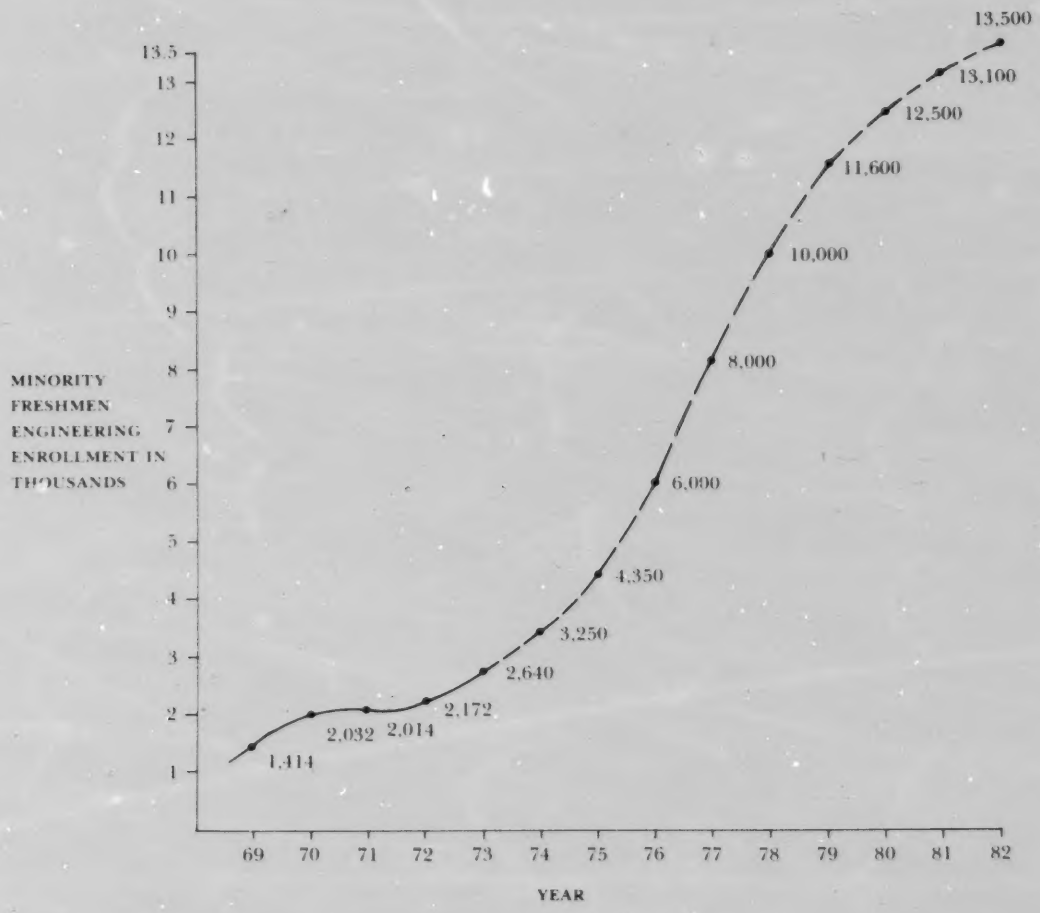


slope of the curve becomes steeper. The curve finally levels off as the innovation takes hold.

The logistic curve seemed suitable to the Task Force for prescribing a realistic pattern of projected growth among minority students in U. S. engineering schools. Fig. 4-2 shows a logistic curve used to target growth from present levels of minority freshman enrollment to 9,807 in 1982 (18% of 54,481, the total for the conservative projection described above). Fig. 4-3 shows a similar curve targeting growth to 13,500 in 1982 (18% of 75,000, the estimated total under the optimistic projection).

FIGURE 4-3

Optimistic Logistic Growth to 13,500 Minority Engineering Freshmen in 1982



The numbers used for past and present minority enrollments need to be explained. It is difficult even now to be sure one has reasonably accurate estimates of the numbers of minority students enrolled in engineering programs. Only quite recently have moderately reliable data been collected on the numbers of Blacks. Data on the other minorities are far less dependable. (See pp. 95 f.f.)

Accordingly, this report has adopted a modification of the method described by Donald G. Dickason of Cornell University for estimating total minority enrollment.[7] For classes entering each fall from 1969 through 1973, the calculations began with the number of Black students estimated to be in the freshman class (Table 4-4).[8] The number for each freshman class was then increased by the percentages shown in Table 4-4 to take into account the fact that in the EMC figures only from 85 to 93% of the Black students reported by engineering schools to EMC in their total undergraduate enrollments are also reported by them in their class-by-class breakdowns of freshmen, sophomores, etc. (see Table 3-17). This adjustment uniformly distributes the unaccounted-for students to the various classes.

Since reliable data on minority engineering students other than Blacks are not available, a second adjustment must be made to estimate the other minorities. The Task Force decided to use a multiplier of 1.33 because three

TABLE 4-4

Estimates of Freshman Enrollment of the Four Underrepresented Minorities in Engineering Schools, 1969-1973

YEAR	EMC COUNT OF BLACK FRESHMEN	% BLACK IDENTIFIED BY CLASS	MULTIPLICATION TO DISTRIBUTE MISSING BLACK FRESHMEN	ESTIMATE OF FOUR MINORITIES
(1)	(2)	(3)	(4)	(5)
1969	977	91.9%	1,063	1,414
1970	1,424	93.2%	1,528	2,032
1971	1,289	85.2%	1,514	2,014
1972	1,477	90.5%	1,633	2,172
1973	1,684	84.8%	1,985	2,640

SOURCES: Cols. 2 and 3 utilize data from *Engineering and Technology Enrollments* for 1969–1973, published by the Engineering Manpower Commission.

Col. 4 was calculated by increasing the number in Col. 2 by the reciprocal of the percentage in Col. 3 to adjust for the freshman share of the Black total not identified by class (full 7-decimal place percentages and their reciprocals were used for the calculation).

Col. 5 was calculated by multiplying the figures in Col. 4 by 1.33 to arrive at an estimate of Blacks plus Chicanos, Puerto Ricans, and American Indians in each freshman class.

separate analyses of the ratio of the four underrepresented groups to Blacks alone suggested this was reasonable (Table 4-5). The number 1.33 was used instead of 1.315 (Table 4-5) since the 1973 college freshmen should be more representative of college trends than 1970 census data. Multiplying the estimated number of Black engineering freshmen by 1.33 produced the estimates of all four minorities shown in Column 5 of Table 4-4.

TABLE 4-5

Ratios of the Four Underrepresented Minorities to Blacks

Minority	1970 Census Data		
	8–14 AGE GROUP	TOTAL POPULATION	1973 COLLEGE FRESHMAN
	(1)	(2)	(3)
Blacks	13.51	11.1	7.8
Mexican Americans	2.92	2.4	1.3
Puerto Ricans	.86	.7	.4
American Indians	.48	.4	.9
	17.77%	14.6%	10.4%
Ratio of 4 Minorities to Blacks	$\frac{17.77}{13.51} = 1.315$	$\frac{14.6}{11.1} = 1.315$	$\frac{10.4}{7.8} = 1.33$

SOURCES: Cols. 1 and 2, *Statistical Abstract of the U. S. 1972.*
Col. 3, *The American Freshman: National Norms for Fall 1973*, p. 39.

PERCENTAGE PROJECTIONS AND YEARLY GOALS

The projections of freshman engineering enrollments and their accompanying minority engineering target enrollments have been assembled into two tables, 4-6, and 4-7. These show the numerical growths in both categories that could be expected with the conservative and optimistic projections of overall freshman enrollment. In addition, the minority numbers are expressed as percentages of toal freshman enrollment for each year from 1972 to 1982 and are shown in Column 4 of Tables 4-6 and 4-7.

A comparison of the percentages for minority freshmen each year (Table 4-8) reveals that even though more substantial numerical growth will be required

TABLE 4-6

Conservative Projection of Minority Engineering Freshman Growth

YEAR	FRESHMAN ENGINEERING ENROLLMENT	MINORITY FRESHMAN ENGINEERING ENROLLMENT	PERCENTAGE OF MINORITY FRESHMEN
(1)	(2)	(3)	(4)
1972 Base	52,100	2,172	4.2%
1973	51,925	2,640	5.1%
	Projected		
1974	53,328	3,250	6.09%
1975	54,016	4,100	7.59%
1976	54,313	5,100	9.39%
1977	54,688	6,200	11.34%
1978	54,813	7,350	13.41%
1979	54,203	8,400	15.50%
1980	54,981	9,000	16.37%
1981	55,230	9,500	17.20%
1982 Target	54,481	9,807	18.0 %

SOURCES: Col. 2 calculated for 1974–79 by using 1978–1983 estimates of B.S. degrees in engineering from *Projection of Educational Statistics to 1982–83*, U. S. Office of Education, National Center for Educational Statistics, and dividing by 0.64.

Numbers for 1980–1982 came from Col. 5, Table 4-3a. Those for 1972–1973 came from the Engineering Manpower Commission.

Col. 3 calculated by choosing minority freshman enrollments from curve shown in Fig. 4-2, approximating *logistic growth* from 2,640 to 9,807 between 1973 and 1982. Numbers for 1972–1973 were calculated as explained in the text.

if the optimistic projection proves more correct, the *percentages* of minority freshmen each year are remarkably close in both models. It is wishful thinking for anyone to try to predict future engineering enrollments, but this comparison suggests that goals for reaching parity among freshmen can be laid out not as numbers of freshmen but as *percentages of freshmen enrollment*. The percentages shown in the last column of Table 4-8 are the averages of the percentages from both growth models. These target percentages could be used as a national blueprint to move the schools of engineering toward parity in minority freshman enrollment by 1982. If enrollment in any one year approximated that shown in the table, it would signify that engineering education was making satisfactory progress toward the 18% goal.

TABLE 4-7

Optimistic Projection of Minority Engineering Freshman Growth

YEAR	FRESHMAN ENGINEERING ENROLLMENT	MINORITY FRESHMAN ENGINEERING ENROLLMENT	PERCENTAGE OF MINORITY FRESHMEN
(1)	(2)	(3)	(4)
1972 Base	52,100	2,172	4.2%
1973	51,925	2,640	5.1%
	Projected		
1974	54,525	3,250	5.96%
1975	57,250	4,350	7.60%
1976	61,000	6,000	9.84%
1977	65,000	8,000	12.31%
1978	69,000	10,000	14.49%
1979	71,500	11,600	16.22%
1980	73,500	12,500	17.01%
1981	74,500	13,100	17.58%
1982 Target	75,000	13,500	18.0 %

SOURCES: Col. 2 calculated by choosing enrollments from curve shown in Fig. 4-1, approximating *logistic growth* from 51,925 to 75,000 between 1973 and 1982.

Col. 3 calculated by choosing minority freshman enrollments from curve shown in Fig. 4-3, approximating *logistic growth* from 2,640 to 13,500 between 1973 and 1982.

The Task Force therefore recommends that the percentages shown in Column 4 of Table 4-8 be adopted by U. S. schools of engineering as national goals for the years 1974-1982 to bring the enrollment of freshmen from the four underrepresented minorities up to parity.

To assure fair representation of each minority within the total for all four, each year's percentage has been divided to show what share each minority represents of the total. This produces the yearly percentage goals for each minority illustrated in Table 4-9.

REALISTIC, REASONABLE GOALS

Are these recommended percentage goals realistic? Do they call for more minority students than can reasonably be expected to be interested in engineer-

TABLE 4-8

Percentage Comparisons of Conservative and Optimistic Projections, and Recommended Percentages

YEAR	CONSERVATIVE PROJECTION (TABLE 4-6)	OPTIMISTIC PROJECTION (TABLE 4-7)	RECOMMENDED PERCENTAGES (MEAN OF (2) & (3) ROUNDED OFF)
(1)	(2)	(3)	(4)
1972 Base	4.2%	4.2%	4.2%
1973	5.1%	5.1%	5.1%
	Projected		
1974	6.09%	5.96%	6.0%
1975	7.59%	7.60%	7.6%
1976	9.39%	9.84%	9.6%
1977	11.34%	12.31%	11.8%
1978	13.41%	14.49%	14.0%
1979	15.50%	16.22%	15.9%
1980	16.37%	17.01%	16.7%
1981	17.20%	17.58%	17.4%
1982 Target	18.00%	18.00%	18.0%

ing? Do they call for any drastic changes in the proportions of students entering college or engineering? Can they be achieved by just "creaming" or redirecting the already well-prepared, college-bound minority youth away from other fields and into engineering?

To get a reasonable estimate of what can actually be accomplished today, recall that the NSSFNS survey of the Black high school seniors in the class of 1973, showed that 5.2%—12.0% of the males and 1.0% of the females—planned to major in engineering.[9] In the academic year 1972–73, by an actual head count, the Office for Civil Rights (OCR) found there were about 322,000 Black, 12,000 American Indian, and 126,000 Spanish-surnamed American twelfth graders enrolled in the country's public schools, (along with 20,000 Asian Americans and almost 2,000,000 whites).[10] According to the Bureau of Labor Statistics, there were about 300 ,000 Blacks graduating from high school in June 1973 and according to the Cooperative Institutional Research Program, (CIRP), there were about 128,600 Black full-time freshmen enrolling in college in the fall of 1973.[11] To consider the magnitude of possible creaming, we should assume

TABLE 4-9

Recommended Percentages of Minority Engineering Freshmen, by Minority

Year	Recommended Overall Percentage (Table 4-8)	Breakdown by Minority			
		BLACK	CHICANO	PUERTO RICAN	AMERICAN INDIAN
(1)	(2)	(3)	(4)	(5)	(6)
1972 Base	4.2%	–	–	–	–
1973	5.1%	–	–	–	–
		Projected			
1974	6.0%	4.56%	0.99%	0.29%	0.16%
1975	7.6%	5.78%	1.25%	0.37%	0.21%
1976	9.6%	7.30%	1.58%	0.46%	0.26%
1977	11.8%	8.97%	1.94%	0.57%	0.32%
1978	14.0%	10.64%	2.30%	0.68%	0.38%
1979	15.9%	12.09%	2.61%	0.77%	0.43%
1980	16.7%	12.70%	2.74%	0.81%	0.45%
1981	17.4%	13.23%	2.86%	0.84%	0.47%
1982 Target	18.0%	13.68%	2.96%	0.87%	0.49%

SOURCES: Col. 3-6 calculated by multiplying the overall percentages by the fraction each minority represents of the total (see Table 4-1, col. 3); i.e., the Black fraction equals 13.51/17.77, or 0.76.

that the academically better prepared students were probably represented by the 72,000 Black freshmen, of which 32,640 were men and 39,360 were women, who CIRP estimated were enrolled in four-year institutions in 1973. From the assumption that these 72,000 students were the well-prepared college-bound youth surveyed by NSSFNS, if we compute 12% of the males and 1% of the females we get about 3,900 males and 400 females who might have shown up as engineering freshmen in 1973. If we had no increases in either college-bound Black high school graduates or their interest in engineering above the 1973 levels, that is the number of Black engineering freshmen we would be getting each year. The 4,300 Black freshmen engineers would correspond to about 5,000 minority freshmen engineers and that is all we could expect if things stay the way they are today.

How close to our goals would these 5,000 minority engineers get us? A glance at both the conservative projections of Table 4-6 and the optimistic

projections of Table 4-7 reveals that we would only get up to about 9% minority representation in engineering freshman enrollments, the level called for by 1976—a point three years away. Since we could achieve the targeted goal for 1976 enrollment, and half the goal for 1982, by merely seeing to it that everyone of the present crop of well-prepared college-bound minorities who wants to be an engineer is actually placed in an engineering school, (perhaps by an admissions clearinghouse and adequate scholarship funds), the Task Force believes the goals in Table 4-8 are realistic.

The preceding analysis indicates to the Task Force that the goals expressed in Table 4-8 *cannot* be met by simply steering the "cream of the crop" into becoming engineering majors. The present college bound crop is just not large enough and is not presently attracted enough by engineering careers. Therefore, the Task Force emphasizes that the goal of 18% representation for minorities in engineering by 1982 cannot be met unless increasing numbers of minority youth begin receiving adequate college preparation in the elementary and high schools and are made more aware of and more interested in engineering careers.

Any successful program to increase minority participation in engineering to equitable levels will require a long-term effort at both the college and precollege levels. In order to make the college enrollment goals expressed in Table 4-8 realistically attainable, **the Task Force also proposes the companion, precollege goals of increasing minority enrollment and retention in academic high school programs, and raising the consciousness and interest of minority youth in engineering careers to the same levels as for the white majority.**

Progress toward these goals may be monitored by further NSSFNS surveys expanded to include the three non-Black underrepresented minorities, or by the existing nationwide standardized testing organizations. The Scholastic Aptitude Test (SAT) of the College Entrance Examination Board (CEEB) and the American College Testing (ACT) tests both collect racial and ethnic data, and probable fields of college study, as well as academic aptitude and performance data. Both CEEB and ACT have expressed great interest in cooperating with engineering organizations to increase opportunities for minority youth.

The engineering enrollments called for in Table 4-8 may seem more attainable if we consider that the population base from which college students representing the four minorities will be drawn during the next decade will be larger by 17% than it has been for the last five years. According to census data, as Table 4-10 shows, in 1970 minority children only comprised about 15.7% of all 18-year olds but they were 19% of the 5-year olds in 1970, and hence will be about 19% of the 18-year olds in 1983. The mean number of minority children for each year in the 15–19 age group in 1970 was 632,835, while that for the 5–13 age group in 1970 was 738,633, an increase of more than 100,000 potential minority students. Thus there should be more minority students going to college and interested in engineering even if only the same proportion is attracted to such education as at present. The national efforts called for and anticipated in this report will be designed to attract an even greater proportion, however. Therefore it appears that there should be sufficient minority students to meet

TABLE 4-10

1970 Age Distribution of the Four Underrepresented Minorities

AGE IN 1970	YEAR THEY MIGHT ENTER COLLEGE	BLACK	MEXICAN AMERICAN	PUERTO RICAN	AMERICAN INDIAN	FOUR MINORITY TOTAL	U. S. TOTAL	PERCENTAGE FOUR MINORITIES ARE OF U. S. TOTAL
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Under 1	1989	482,208	120,282	44,097	18,886	665,473	3,485,277	19.1%
1	1988	457,641	115,147	38,796	17,722	629,306	3,377,502	18.6%
2	1987	465,840	111,266	39,153	17,909	634,168	3,290,419	19.3%
3	1986	481,680	113,950	39,870	17,971	653,411	3,418,679	19.1%
4	1985	523,419	123,006	42,919	18,968	708,312	3,582,460	19.8%
5	1984	533,860	125,727	42,146	20,064	721,797	3,811,077	18.9%
6	1983	552,583	127,901	42,220	20,417	743,121	3,952,146	18.8%
7	1982	558,992	128,134	40,016	20,630	747,772	4,012,474	18.6%
8	1981	553,061	126,115	38,776	20,284	738,236		
9	1980	561,264	127,152	38,227	20,710	747,353		
10	1979	580,426	126,476	37,754	20,876	765,532	8 – 14 =	8 – 14 =
11	1978	556,538	121,009	35,442	19,106	732,095	28,970,018	17.9%
12	1977	560,956	119,449	33,831	19,526	733,762		
13	1976	551,464	115,514	33,237	19,408	719,623		
14	1975	569,061	114,690	33,972	19,213	736,936		
15	1974	545,539	113,424	31,245	18,966	709,174	4,029,034	17.6%
16	1973	512,156	107,815	27,702	17,305	664,978	3,889,652	17.1%
17	1972	489,962	104,203	27,536	17,075	638,776	3,825,343	16.7%
18	1971	454,154	95,002	25,627	16,208	590,991	3,776,102	15.7%
19	1970	428,894	88,942	27,888	14,551	560,275	3,560,217	15.7%
20	1968	403,541	82,668	26,984	14,589	527,782	3,490,530	15.1%

SOURCES: Col. 2 represents a rough estimate of when each age group could enter college as freshmen assuming they entered at age 18. Cols. 3–6 were obtained from three Department of Commerce, Census of Population, 1970, Subject Reports: Col. 3 from report PC(2)-1B, *Negro Population*, Table 2; Cols. 4 and 5 from PC(2)-1C, *Persons of Spanish Origin*, Table 3; Col. 6 from PC(2)-1F, *American Indians*, Table 2. Col. 7 is the total of Cols. 3–6. Col. 8 was obtained from 1970 Census of the Population, U. S. Summary, *Characteristics of the Population*, Table 50. Col. 9 is the percentage equaling Col. 7 divided by Col. 8.

the enrollment goals. Finally, as Table 4-3 makes clear, the overall estimates of high school graduates, college freshmen, and freshman engineering enrollment do not anticipate any great changes in the overall proportions of either college freshmen or engineering freshmen.

Thus, in the opinion of the Task Force, the goals specified in Table 4-8 are entirely realistic and reasonable. The percentages are within reach and yet represent a challenge to engineering schools to demonstrate their concern for minority needs. The goals sufficiently accelerate minority enrollment to serve as a sign of good faith toward Blacks, Chicanos, Puerto Ricans, and American Indians on the part of the engineering profession.

MEASURING ACCOMPLISHMENT

The success of efforts to reach a total of 18% Black, Chicano, Puerto Rican and American Indian representation among engineering freshmen by 1982 will depend upon steady progress toward that goal. In order to assure steady progress, performance will have to be measured regularly. The Task Force believes that the annual enrollment data collected by the Engineering Manpower Commission of the Engineers Joint Council are more reliable than data from any other source. Accordingly, the Task Force recommends that annual EMC enrollment figures form the foundation of the monitoring effort. Estimates of the numbers of Chicano, Puerto Rican, and American Indian students may be developed from Black data, as in Table 4-4, but it is hoped that very soon more precise methods of counting these students will come into use. Estimates should be obtained not only for freshmen but for each undergraduate class in order to measure engineering schools' accomplishments each year in admitting and retaining more minority students.

MINORITY GRADUATE EDUCATION

Our four designated minorities have been even more dramatically underrepresented in engineering education at the graduate level than at the undergraduate level. In 1973, only 104 of the 17,700 engineering master's degrees and only 13 of the 3,890 engineering doctorates were awarded to Blacks, while they received 657 of the country's 45,510 bachelor's degrees in engineering. Blacks thus earned 0.6% of the nation's master's degrees, and 0.3% of the doctoral degrees, proportions only two- to four-fifths as much as their 1.4% share of the bachelor's degrees that year.[12] As Table 4-11 chronicles, Black participation in graduate engineering programs has been token for quite some time.

Although data for Chicanos, Puerto Ricans and American Indians are not available, they are comparably poorly represented in the nation's graduate engineering programs, since, in 1973 there were only 93 masters and 11 doctoral

TABLE 4-11

Undergraduate and Graduate Degrees in Engineering

	Total Engineering Degrees			Black		
Year	B.S.	M.S.	PH.D.	B.S.	M.S.	PH.D.
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1969	41,248	15,372	3,391	314	17	2
1970	44,479	15,723	3,691	378	50	1
1971	44,898	16,443	3,638	407	47	8
1972	45,870	17,400	3,690	579	78	13
1973	45,510	17,700	3,890	657	104	13

SOURCE: NCES, HEW figures as extracted in Table 3 of John D. Alden, "Opportunities for Engineering Graduates 1974–1984," *Engineering Education*, April 1974.

degrees awarded to all Spanish-surnamed and only 15 masters and 1 doctoral degree awarded to American Indian students.[13]

It has long been recognized that an advanced degree affords access to higher level entry positions, provides greater security, and improves an engineer's ability to transfer to positions of greater opportunity.[14] The mere fact that 64% of all bachelor's degree recipients in engineering have undertaken graduate study and that 35% of them have done so in engineering,[15] means that those minority engineers interested in advancement to top technical positions can ill afford to compete armed with only undergraduate technical educations.

There is another important reason why minority engineers must be encouraged to go on to graduate study. Even though there may be lessening demand for engineering Ph.D.'s because of the enrollment decline in engineering schools, there is a dramatic need for minority Ph.D.'s in faculty and research positions. A country that only produces 13 Black Ph.D.'s a year, in all fields of engineering, cannot even meet the staffing needs of the six Black engineering schools, let alone the hundreds of white engineering schools, all anxious to hire Black faculty to teach and serve as role models for minority students.

For these reasons, **the Task Force recommends that minority students should also be represented in graduate engineering education in proportion to their representation in the population.** Rather than set specific numerical or percentage enrollment goals at this time, the Task Force recommends that graduate departments of engineering work aggressively for the next few years for increased minority representation in their full-time and part-time degree programs with the short-term goal of producing sorely needed minority faculty and role models.

Until the pool of minority bachelor's degree recipients increases to adequate levels a decade from now, the graduate engineering schools should be prepared to recruit actively from the substantially larger pools of minority science and math undergraduates, particularly from Black liberal arts colleges, and from those minority engineering and science graduates in the work force who see the utility of an advanced degree. Engineering educators should emphasize the ease of transition from undergraduate science curricula to graduate work in most fields of engineering. Most minority students with science backgrounds find it necessary and desirable to take selected undergraduate engineering courses as a part of their graduate programs to enhance their effectiveness in engineering. It should be emphasized that in many graduate departments of engineering, such as operations research, computer fields, and areas of electrical, mechanical, and civil engineering, an undergraduate degree in mathematics, computer science, physics or chemistry has long been recognized as a desirable preparation.

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Mechanisms for Progress

If we are to overcome the obstacles to increased minority engineering and college enrollment and attain the goals spelled out in the preceding chapter, a great many functions will have to be performed in a coordinated fashion. Among these tasks are:

- To raise new funds which will supplement existing (and projected) government, institutional and private resources.
- To redirect existing funds and allocate new funds in accordance with highest priority needs for student financial aid and the cluster of services needed to identify, recruit and maintain minority engineering students.
- To identify potential students and match them up with cooperating institutions and the necessary support funds.
- To identify cooperating institutions and establish with them mechanisms and agreements for participation in the program.
- To work with counselors and teachers in secondary schools and in federally supported programs (Talent Search, Upward Bound, etc.) to assist them in guiding promising students toward engineering.
- To develop and support tutorial and counseling programs at colleges, both summer and in-term, to help prepare students bound for engineering, and to assist them in making up for previous educational deficiencies.
- To create acceptance for engineering as a career among minority groups.
- To establish a data collection system that will accurately determine progress toward the program's goals.

There are others, to be sure. Taken together, these tasks add up to an enormous undertaking.

NATIONAL LEVEL STRUCTURE

Bits and pieces of this array of functions are now being dealt with, and in many cases quite ably, by existing organizations. Yet there is no existing agency with all the various characteristics needed to carry out this task. Most of those now operating have other priorities that might dilute their efforts in the

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minority engineering area. And for any one of them to seek to be established as the dominant organization for the program would probably discourage many of the others from full participation, or even continuation of their existing efforts. The Task Force concludes most strongly, however, that there is a need to organize a cohesive, national activity to ensure that essential tasks are performed. The challenge is to determine that combination of organizational mechanisms best suited to accomplishing the essential functions.

Designing an Effective Structure

A national effort to increase minority engineering enrollments which brings together existing efforts and organizations could be structured in a number of ways. It might be designed around the concept of a strong, central agency which raises and disburses funds and fills the gaps that now exist in the areas of motivation, identification, recruitment, matching of students with institutions, etc.

There are many aspects of the problem, however, which can be dealt with more effectively in a decentralized fashion, and there are other organizational alternatives that should be carefully examined. This examination should include a thorough assessment of the interests and abilities of existing organizations. It must also be based upon an evaluation of the experiences—successes and frustrations--of efforts recently mounted to increase minority participation in Medicine, Law, and Management. On these we report briefly here:

Medicine. This program utilized and expanded upon a single long-existing organization—National Medical Fellowships, Inc. (NMF)—which has taken the lead in raising and dispensing student aid funds. Recruiting has been less of a concern, given a field where applicants outnumber available slots by a wide margin. The fact that the NMF board is dominated by medical educators has limited its ability to raise funds. Funding is on the order of $2 million per year, mostly from foundations with some federal, corporate and private support.

Law. When a number of legal professional and educational organizations began to move to increase minority enrollments in this field, they established the Council on Legal Education Opportunity (CLEO) as its coordinating unit. CLEO took the lead in establishing and funding summer institutes and providing financial aid to students successfully completing summer programs. Funding began with a $2 million foundation grant, and later shifted to federal sources which are now drying up. Only minor sums have been raised from private sources, and CLEO still hopes to operate predominantly from federal funds, relying strongly on support legislation now in the Congress.

A number of other agencies have been active in the legal field, and there is little coordination among them. Most serve the interests of particular minority groups, and one (the Earl Warren fund, supported by foundation grants) concentrates on Blacks in the southeastern states. The total number of students reached is small, considering the field. CLEO, the largest of the agencies, accomodates some 200 new students per year.

Management. In this field, the emphasis has been on consortia of institutions working through their own central agencies. The Council for Opportunity in Graduate Management Education (COGME) represents ten leading management/business schools. It is dominated by business school administrators, primarily deans, and since deans have many other things to raise funds for, has faced its greatest obstacle in raising adequate sums. The total fund-raising goal for next year is $400,000, most of which is anticipated from industry. The principal function of COGME is provision of fellowships; recruitment is primarily up to the institutions, but the central staff devotes a good deal of effort to encouraging able students to consider management education.

The Consortium for Graduate Study in Management consists of six institutions from coast to coast. The Consortium board is dominated by faculty members, and they devote considerable time to fund raising and recruiting. Most of the $600,000 budget is expended for student aid.

Two other consortia have been in the picture. One, in the south, never really got off the ground. The other (ABLE, centered in the northeast) went out of business when the federal funding on which it relied dried up.

Unlike the other two professional fields discussed, there is no national effort in management education.

This brief review of the medicine, law and management programs, the diversity of organizational approaches they employed, and the uneven successes they have achieved, indicates to the Task Force that while there is much to be learned from a careful analysis of these efforts, they do not constitute a paradigm for increasing minorities in engineering.

Structural Options

A major activity can be carried out in a number of ways. In decreasing levels of effectiveness for assuring that things are going to happen, the leadership options can be described as follows:

1. The activity can be **managed.** The responsibility, authority, and resources to support the project are focused in a lead group. All other participants derive their authorities and resources from the lead group.
2. The activity can be **steered.** If the activity does not lend itself to a focused assignment to a lead group because of a plurality of interests and diverse origins of resources, it can be managed by a steering committee. This requires that the independent participants agree to surrender at least some of their decision-making prerogatives to the collective judgment of their peers in order to maximize the overall effectiveness of the total effort.
3. The activity can be **coordinated.** Without surrendering their independent prerogatives, the individual participants can agree to make full and complete detailed disclosures of their current activities and future plans so that other participants can factor these actions into their own plans.

When good will and flexibility abound a degree of steering can result, but always at the option of the affected participants.

4. The activity can be **overviewed.** The participants may balk at disclosing their actions and plans to their co-participants, but agree to furnish such information to a discreet non-participant group in order to obtain an objective critique of the effectiveness and sufficiency of the actions in reaching the goals of the activity. The participants do not bind themselves to implement the findings of the overview group.
5. The activity can be **catalyzed.** A non-participant group can set itself up on a good offices basis to provide a forum and serve as a sounding board for ideas, comments, and suggestions from interested parties to the activity. It communicates its findings to participants for their consideration and possible implementation. Inherently, the impact of the group will be a function of the intellectual and emotional appeal of its findings and the prestige of the group and its members.

Because of the large number of organizations with programs planned or activities already underway, and because of the complexities involved in attaining the increased minority engineering enrollments recommended in Chapter 4, the Task Force believes that a national **coordination** effort (Option 3) represents the highest practical leadership role that can be brought to bear on such a major activity. In the area of fund raising and channelling financial aid to the minority engineering students enrolled, the area the Task Force considers to be of the highest priority, a **steering** role (Option 2) seems necessary in order to adequately develop new funding sources and to keep overhead costs at a minimum.

Participating Agencies

There are many existing organizations with special capabilities and interests that would be logical participants in any coordinated national effort to increase minority engineering enrollments. They include:

1. **The National Academy of Engineering** (NAE) is an organization which has already begun to provide some coordination in response to a mandate from the large and representative number of participants in the May 1973 Symposium on Increasing Minority Participation in Engineering. Participants in this top level symposium unanimously established as a national goal a ten-fold increase in minority engineering graduates within a decade, and passed two implementing recommendations:
   - That the National Academy of Engineering establish a Standing Committee on Minorities in Engineering composed of a cross section of Symposium delegates to include engineering educators, members of minority groups and representatives of industry and professional-technical organizations.
   - That the National Academy of Engineering take the initiative in exploring with industry, government and educators the feasibility of creating a National Council on Minorities in Engineering.

While NAE is primarily an honorific, advisory organization, without major program activities, it has been pressed into—and has accepted—a significant role in this area. It is building staff competence to work on minority matters, has assembled top-level advisory bodies, and has begun to generate resources for a long-term effort.

2. **Engineers' Council for Professional Development** (ECPD) founded in 1932 serves as a forum and action arm for the 14 major national engineering societies (2 others in the admission process) in certain areas, such as accreditation, student activities, professional development and ethics. Since its inception it has had the responsibility for the overall general guidance of engineering. It provides facilities and support for the national headquarters of JETS and ME^3 and administers the MITE (Minority Introduction to Engineering) summer programs for minority precollege youth.
3. **Minority Engineering Education Effort** (ME^3) Task Force is a special group of educators, professional society members, industrial representatives and other interested parties. Its main goal is to work towards identifying, motivating and interesting students from minority groups to consider a career in engineering. This group distributes two films and over 200,000 tracts on guidance each year and exhibits motivational material at both local and national conventions and professional meetings. It compiles lists of minority students interested in engineering and provides these lists to engineering colleges seeking minority students.
4. **National Executive Committee on Guidance** (NECG). Since 1971 the engineering profession has embarked on a guidance program centered on three organizations and their respective constituencies: the National Society of Professional Engineers (NSPE), responsible for organizing state and local efforts in the guidance councils; the American Society for Engineering Education (ASEE), in charge of supplying the educational expertise to the program and its participants; and the Engineers Council for Professional Development (ECPD), which develops programs, publications and audio visual equipment. This joint effort speaks for engineering in guidance matters. The individual engineering societies continue to prepare publications, and implement their special guidance programs. However, their activity is coordinated with the NECG. The program has a state organization, provides information, speakers and counselors. This effort represents over 360 educational institutions, 14 national engineering societies with over 700,000 individual members and 900 chapters.
5. **Junior Engineering Technical Society** (JETS) is an independent engineering organization concerned with the high school student. It encourages the formation of chapters or clubs of students interested in engineering. Each chapter is supported by a faculty adviser and an engineering adviser. A coordinator is assigned to each state. JETS publishes literature on its program and conducts the yearly National Engineering Aptitude Search (NEAS), a program based on a special test

designed to identify possible success in a college of engineering. JETS chapters number 1500. NEAS yearly participants average over 8000 students in grades 9 through 12.

6. **Engineers Joint Council** (EJC). Engineering manpower studies and data gathering on students are mostly centered in the Engineering Manpower Commission of EJC, and provide the basis for improved determination of trends and progress against our goals.
7. **American Society for Engineering Education** (ASEE) is primarily representative of engineering educators. As such it could help to build support for minority programs on the campuses, and improve the level of counseling, tutoring and adocacy necessary to our purpose.
8. **The National Advisory Council on Minorities in Engineering** (NACME) is a recently created group of concerned leaders of industry, government, minority organizations, professional societies and education. This group, which represents the highest echelons of decision-making and influence in the country, has volunteered to advise and contribute to a national effort to increase minority access to engineering.
9. **National Scholarship Service and Fund for Negro Students** (NSSFNS) has played a major role in identifying, encouraging, counseling, and referring Black eleventh and twelfth grade high school students to post-secondary institutions using algorithms which maximize the likelihood of college admission with adequate financial aid and academic success. NSSFNS is concerned with the entire range of problems, situations, procedures and processes confronted by or set as barriers to Black students' quests for education beyond high school, and has indicated a willingness to expand its efforts to include other minorities in addition to Blacks. Hence, NSSFNS can be counted on to mesh its efforts with any proposed engineering program, and to provide valuable counsel in finding ways to draw more minority students into engineering.
10. **Other National Minority Programs: Aspira, the League of United Latin American Citizens (LULAC), the Society for the Advancement of Chicanos and Native Americans in Science, the Urban League, the National Educational Task Force de la Raza, El Congreso Nacional de Asuntos Colegiales, the National Achievement Scholarship Program of the National Merit Scholarship Corporation, the Upper Division Scholarship Program of the College Board** and other organizations working to help minorities obtain better educations in all fields can be counted on to continue helping in the identification and support of minorities in engineering, and to intensify their efforts in the engineering area if more aid and encouragement become available. Those most potentially active should be represented in any national program, and in turn looked to for assistance in meeting our goals.

The National Achievement and Upper Division programs deserve special mention because of their potential value in recruiting. The National Achievement Program is presently set up only to select "Out-

standing Negro Students," but has expressed a keen interest in enlarging its selection process to include Mexican American, Puerto Rican and American Indian high school students as well as Blacks. The Upper Division Program is already serving all four of the minorities underrepresented in engineering and selects outstanding minority students graduating from community colleges who desire to complete their educations at senior colleges and universities. Both programs are highly selective, and thus honorific. Attracting a few winners in these programs into engineering would help to promote interest in engineering, since these winners are so visible to their classmates and community. Some close collaborative arrangement with our program, possibly including subsidy of added scholarships in engineering, would appear justified by the recruitment value of these programs.

11. **Industry and Business Groups.** Individual industries presently sponsoring significant minority engineering programs could also be represented. In addition, such organizations as the U. S. Chamber of Commerce, the National Association of Manufacturers, the National Alliance of Businessmen, and the Conference Board might prove helpful in a variety of ways, and might well be represented on the governing board of any coordinating agency.
12. **Other national agencies concerned with scientific and engineering education: The American Association for the Advancement of Science (AAAS), the National Science Foundation (NSF), the National Institutes of Health (NIH), the Department of Health Education and Welfare (HEW)** and other societies and agencies interested in improving the science education of minorities should be utilized and collaborated with in preparing better elementary and high school science curricula, compensatory pre-college programs, and graduate fellowship programs to train minority engineering and science faculty for college and pre-college teaching careers.

THE RECOMMENDED STRUCTURES

Coordination. The Task Force believes that the National Academy of Engineering (NAE) should be urged to provide the necessary national coordination of existing and proposed minority engineering programs. Because the Academy's membership embraces all elements of the engineering profession on the national level, because of its high prestige and advisory role to government, the engineering community, and the nation as a whole, and because of its existing staff and program capabilities, the Academy appears to be the logical mechanism to play a facilitating and leadership role. Most of the agencies described in the last subsection are already represented in the standing NAE Committee on Minorities in Engineering (COME). This committee can be expanded to include other key groups and perhaps have its name changed to the

Coordinating Committee on Minorities in Engineering (CCME) to reflect this new role.*

Fund Raising. The Task Force is convinced that the single most important obstacle today to increasing minority participation in engineering is the inadequate supply of financial aid for minority college students. Because of this critical need, the Task Force recommends that a new national organization be established as soon as possible, to raise and distribute college scholarship funds for minority engineering students. In addition to distributing scholarships to college students, this fund-raising organization may award per capita grants of small amounts to the institutions which the students choose to attend as an incentive for the institutions to provide tutoring, counseling and other supportive services for an increasing number of minority students.

The new fund-raising organization, which might be called NESF, for National Engineering Scholarship Fund, or some other suitable name, should be free standing and operate under its own charter. It should maintain close working ties with other groups concerned with the problem and should, of course, be represented in the Coordinating Committee called for above. It is essential, also, that the agency be so structured as to permit tax-exempt status under internal revenue codes. Obtaining tax exemption takes time—six months or more. During the period preceding the awarding of full tax exemption some arrangements will have to be made with an affilitated tax-exempt organization in order to channel gift funds.

Effective fund raising calls for the assembling of a small, but well-qualified staff of tested professionals. Its members should be selected for their ability to deal at high management levels with corporations and other potential funding sources;, and with the same high level of personnel in educational institutions. To offset high start-up administrative costs, and the costs of fund-raising, the Task Force urges foundation support for the first five years of NESF's operation to assure donors that a maximum share of money contributed would be utilized for direct assistance to students.

Under the rubric of financial aid adminstration falls the task of dealing with the applicants, other agencies, and educational institutions. This will include assessing potential students, determining grant eligibility based on need, and, in some cases, facilitating proper match-ups between applicants and institutions. Thus, the staff of NESF must include knowledgeable financial aid professionals competent to establish fund delivery and accounting systems. In addition, there will be a need for data gathering capabilities and correlation with recruiting and identification efforts of other groups. The capabilities of the computer and the application of humane judgment will have to be carefully balanced. It is likely that much of the mechanical work in this area can be farmed out to the Educational Testing Service (ETS) and/or the American College Testing (ACT)

*The Task Force confesses to being tempted to name things. It is barely able to resist naming the coordinating committee the Engineering Equality for Minorities Coordinating Committee and calling it $\mathbf{E = MC^2}$.

on a contract basis, without losing the identity and control of the program agency. Such work can be handled at a cost of about 5% of financial aid funds disbursed, based on the experience of existing arrangements between these organizations and state scholarship programs.

Throughout the rest of this report we shall use the temporary names "Coordinating Committee" and "NESF" to represent the coordination and fund raising structures we feel are necessary. We shall sometimes use "program" or "our program" or the "national effort" to stand for the entire coordinated national activity.

LINKING TO INSTITUTIONS AND STUDENTS

The success of the national program to increase minority participation in engineering, once proper financial support is generated by NESF, is ultimately dependent upon the colleges which must educate the students. They will have to admit the students, to conduct the tutorial and support activities which may be required, and to handle the details of financial aid. Institutions participating in NESF will have to share in the commitment to the program's goals and accept the obligations that go with participation.

One of the most important obligations lies in the handling of student aid funds. We deliberated at length as to mechanisms for equitably channeling student grants, which assure that aid funds from NESF are indeed used to increase minority enrollments, rather than diverting existing funds to other activities or to other students. We have concluded that this can best be accomplished in the spirit of the program by addressing letters to institutional officials which explicitly state the conditions of participation. In order to assure proper communication and cooperation, these conditions should be accepted in writing both by the institutional officer or officers responsible for student aid and support programs and by the deans of engineering.

The details of this letter of understanding should draw upon existing federal regulations designed to prevent diversion of aid funds, and should be consistent with legal necessities relating to tax exemption and foundation operations. In addition to spelling out the conditions for using NESF funds, the understandings should call for reasonable reporting on the use of funds and provide for audits where this appears necessary.

Channeling Institutional Funding

The total program funding that will be required at the college level by the institutions enrolling the called-for numbers of additional minority engineering students will be of three types: student financial aid grants, subsidies for in-term support services, and funding for summer programs and special support services. We will take these up in order of increasing complexity—the reverse of the sequence listed.

In Chapter 6 we make a detailed analysis of the anticipated costs of educating the new students called for in our national effort and we develop target figures primarily to show gross financial need. The actual amounts employed in the program are, of course, subject to refinements by NESF, the specific agency charged with administering the scholarship component. We believe, however, the figures developed are realistic, and can be used illustratively in spelling out general policy recommendations.

Summer Tutorials. Many admitted students will be diagnosed as needing extensive remedial work before entering engineering school, and some may require additional summer tutorial work later. Institutions with significant numbers of incoming minority students will generally set up their own summer programs, and for this purpose we consider that 20 or more students would represent an appropriate minimal size for such a program. If there are schools that do not have students of sufficient number to mount programs of their own, it would be appropriate to provide for a relatively small number of programs which would attract students from a number of different neighboring institutions and provide one unified and cohesive summer tutorial program. We estimate that summer tutorial programs would cost about $800 per participating student, and that 60% of the incoming students would require such help. Thus the average cost per entering student in our program would be about $480. These figures are useful for planning purposes, but as indicated above, we recommend that individual contracts be negotiated by funding agencies with sponsoring institutions to cover actual costs.

A possibility for reducing the cost of summer tutorials, and perhaps other support services as well, lies in the federal Special Programs for Disadvantaged Students, including Upward Bound. The potential of these programs is discussed in greater detail later in this chapter.

Support Services. Our cost projections in Chapter 6 call for an allowance of $150 per minority engineering student enrolled under our program during the first two years of college. Experience may indicate the need to adjust this figure, but it should be satisfactory at the outset. As an incentive for the colleges to increase minority enrollments and retention, we propose that $150 multiplied by the number of lower division minority students enrolled at each institution under our program might be paid by NESF directly to the institutions for use in special counseling and tutoring. Terms for using and accounting for special incentive funds would, of course, be spelled out in the letters of agreement with the institutions described above. Effective use of such funds should be a criterion for continuing an institution in the program.

Student Aid. In working out our recommendation for NESF on the allocation and distribution of student financial aid we took account of a number of factors and preferences:

1. Grant aid funds for minority students currently enrolled are often inadequate because they force undue reliance on "self-help" (work, savings, and loans) which inhibits enrollment growth in so demanding a field as engineering. We urge the establishment of realistic limits on the amount of self-help. Fortunately,. policies covering federal grants do

permit reducing the self-help portion of student budgets without affecting other aid funds.

2. Students recruited into our program should be identified with the program. For example, participants might be known as "National Engineering Scholarship Fund (or whatever name is picked for it) Scholars" to foster a closer sense of identity with engineering.
3. Although it will be necessary for NESF to make actual payments through financial aid offices at institutions, the grants in aid should be designated directly for selected students. These should be completely portable by students and resemble vouchers which students can "cash" at whatever institution they select, and to which they are admitted under the institution's criteria.
4. The precedent established by other programs (e.g., National Achievement Awards, Upper Division) indicates that, under present interpretations there is no legal prohibition on limiting our NESF awards to selected minorities.
5. Awards made by NESF should be based on need or a portion of need, up to a given maximum figure. The actual amount of each award paid will be determined by the policies and computed student budgets set by the financial aid officers of the institutions attended.
6. Participating institutions will be expected to provide the full aid need requirement of selected students, and wherever possible adhere to the limitations on self-help which the program specifies.

In Chapter 6, using the most refined data available from the engineering colleges and the college financial aid community on student budgets, we show that it will cost an average of $2,188 (at predominantly Black schools), $2,834 (at public universities), and $5,140 (at private universities) per academic year for each minority engineering student (based on 1975–76 figures). We based our computation of these average per-student costs on a weighted average of the costs at both public and private institutions—weighted in accordance with total enrollment within each category of selected institutions, and in accordance with the split in BS degree production between public and private (rounded to 70%–30%). When we subtract from these costs the amount of expected parental contributions and the expected assistance from federal student-aid programs, we show in Chapter 6 that it will cost an average of $702 at predominantly Black schools, $937 at public universities and $2983 at private universities, per student, per academic year. This computation suggests to the Task Force that a maximum grant of $1,500 per student in supplementary aid from NESF would cover the full requirement in public universities and at the predominantly Black colleges and would ensure student access to the country's private schools. While this supplementary aid would be cordially welcomed by the private colleges, it would not be adequate to cover need at many of them; thus they would have to generate the necessary institutional funds to permit them to participate.

Self-help. We have referred to the current emphasis on self-help (work, loans, etc.) in the financial aid packages of minority engineering students and the need to keep it down to acceptable levels if our goal of increasing enrollments is

to be attained, unless engineering-related employment is available and desirable for particular needs. Since many of the additional students may have to spend the precollege summer in intensive tutorial programs, and since unsubsidized jobs are very hard to come by for the rest, we do not count on summer earnings or savings from past employment of entering freshmen in our computation of available self-help. Likewise it seems unrealistic to ask these students who are overcoming educational deficiencies by taking part in tutorial programs to work during the academic year for at least the first two years when engineering attrition is the most severe.

Earnings from summer jobs should play a part for many students after the freshman year, and jobs during the academic year could provide partial support from the junior year onward. But we would urge that expected reliance on earnings be kept at realistic levels—not over $500 net from a summer or the result of 10 hours per week of work during the school year. In setting even these levels we should make note of the difficulty minority students have in getting jobs in many parts of the country. We would urge participating institutions to help these students, however they can, to get appropriate summer employment, and to take full advantage of work-study programs. Industries and other organizations utilizing engineers should also be urged to employ as large a number of summer interns as they can handle in meaningful work. These summer jobs should not just keep the intern busy, or simply compensated for doing nothing useful, but should be designed to increase motivation toward the goal of graduating as an engineer.

We have examined at length the role of loans in the financing package. Requiring beginning students to rely heavily on loans while embarking on a program that may appear fraught with obstacles would seriously hamper our recruiting efforts. Just undertaking an engineering education, which only half of the well-prepared white entrants manage to successfully complete, may seem very chancy to many minority students, and asking them to go into debt in the process may be too much.

We have also discussed the idea of forgiveable loans—forgiveable for those who complete the BS in engineering—as a way of assuaging fears. This might work in special circumstances, but in general has the effect of doubly penalizing those who can't or don't make it, thus discouraging many prospects from even trying. We do not see this as a large-scale alternative.

We would have preferred to avoid loans in the financial aid package but, as we show in Chapter 6, the total new funding required for scholarship assistance for the increased enrollments is so large that we must accept the likelihood that many of our added minority students may have to borrow up to $500 per year for the self-help components of their educational expenses. Still we recommend at least deferring the reliance on loans until the junior year, when success appears to the student to be in sight. We also recognize the inevitability of resentment by many students toward the introduction of a loan into their packages after two years of full support, despite earlier warnings that this is the policy. One possible way around this problem if loans must be introduced into the package, would be to make very small token loans, of say $100, a part of the

aid package during the first two years so that later heavier reliance on loans does not come as too much of a shock.

In summary, we strongly favor aid packages up to full demonstrated need, with no reliance on student earnings during the freshman year, reliance only on summer earnings for the sophomore year (provided jobs can be found), reliance on loans or modest summer and in-term earnings as an important factor only during the junior and senior years. To do otherwise will interfere with the success of the program, given the demands of an engineering education and the formidable barrier it represents to many minority students. The details and ultimate mix of the aid distribution, of course, will have to be worked out by our proposed scholarship agency (NESF), and by the participating institutions.

Selecting Scholarship Recipients

In order to achieve their broad social purpose, our financial aid funds should be available to all students who have a reasonable chance of success in engineering. This would argue for a declaration that NESF assistance is available to all minority students who wish to enter engineering and who are admitted to an engineering program. But if we are successful in attracting more applicants than NESF can support, some criteria for selecting those who are promised awards (subject to admission to an engineering program) will have to be devised.

We would prefer that a demonstration of interest and ability in science and mathematics, as reported by teachers or counselors, or by transcripts, be stipulated as the major selection criterion. This would get around heavy reliance on standardized aptitude tests, which are viewed as suspect by many minority people; or on class standing or some other measure of high school performance, which might not be very reliable if the rigor of the high school program is unknown.

If it becomes necessary to screen and rank applicants, we would place highest value on determination of satisfactory completion of three years of mathematics and two years of science in high school, or some other clear evidence of promise, but we would not like to see such guidelines becoming restrictive. Once students have been ranked according to these criteria, aid up to full need would be offered to students from the top of the list down until funds are exhausted or the year's target met.

Although we discourage the use of standardized tests as the major screening device, the program should not overlook the value of test participation as a way of identifying well motivated students in the college-bound pool. Between them the SAT and the ACT tests are taken by 80–85% of all high school students who are entering college. The ME³ program is already using data from test lists to identify prospective engineers, and this device should continue to be used. Both ETS and ACT have indicated their desire to cooperate with our effort by identifying additional minority students interested in engineering or science. Obtaining these data from junior year test-takers (PSAT) would provide additional time to link minority high school students with engineering.

Other sources of help in identifying prospective students, which should not be overlooked, include the engineering schools themselves, and the special agencies such as NSSFNS and National Achievement Scholarship Program already searching out and helping promising minority students. With all of these sources of assistance we believe that the target number of applicants can be reached. If the number of applicants greatly exceeds our goals, if available funds fall short of computed need, there may be serious difficulty in ranking and selecting those who will be promised support. This may well become a major problem, and we can only hope that a workable scheme can be devised within the guidelines of broad access stipulated above.

OTHER OPPORTUNITIES AND MECHANISMS

The preceding discussion covers the programs and assumptions that are taken into account in the following chapter in which we develop total cost estimates. There are other opportunities for bringing students into engineering which have promise, and which could sharply reduce the burden on our program. At the same time these programs provide a redemptive mechanism for salvaging some of the vast pool of minority youth who presently "fall between the cracks" in the country's educational delivery system. Notable among these are the opportunity to engage the armed forces, through their education programs, in a concerted effort to channel service personnel and their dependents into engineering; and several specialized federal programs that could help to build and sustain minority engineering enrollments. We report on these programs in some detail here as matters that could and should be closely related to our program.

Armed Services Programs

Our attention in this report has been concentrated on doing the job through conventional education channels. In devising strategies and estimating costs we have assumed the normal flow of students from secondary school to college, primarily because so little is known about alternative routes.

Some alternative channels may become significant in reaching our goal, and could have the effect of reducing the cost and magnitude of our effort. Most promising among these is the possibility of working through the educational programs of the armed services.

With the draft ended, the services must rely on volunteers. Perusal of the recruiting literature in any Post Office makes it clear that the services are relying heavily on the educational opportunities they provide as a lure for recruits, and these education programs are expanding rapidly at the college level. This is a particularly opportune time to encourage development of engineering and pre-engineering programs in the armed forces, according to Department of

Defense officials. They have encouraged initiatives from the education community, and agencies such as those we intend to involve in our program.

Naturally, any major engineering education program in the armed forces would be open to all personnel. But since minorities are a substantial proportion of service men and women, the opportunity to attract a large number of minority persons is at hand. Blacks, the only group separately reported, now make up 20% of new enlistments in the services, and other minorities are probably as well represented. There is every reason to expect that our program could attract a substantial proportion of minority engineering students, especially if we are able to offer special financial aid incentives following discharge.

The very magnitude of education in the armed services makes this fertile ground for our program. In 1972–73 208,000 men and women in uniform undertook college level work under the Defense Department tuition assistance program. This number is projected to rise to 309,500 in 1974–75. Another 92,700 took advantage of the in-service GI Bill benefits to pursue college level work last year. The average load carried is about seven semester credit hours each year—nearly one-fourth of a full time college load. Another 141,000 were engaged in high school level or remedial work last year, and many of them plan to go on with post-secondary study.

A number of events are converging to create a propitious climate for developing engineering programs for service personnel, and we summarize a few of them here.

- First, of course, is the shift to all-volunteer services mentioned above, and the heightened emphasis on education as a consequence of the need to recruit, and in order to meet the growing need for highly trained personnel in the services.
- The U. S. Armed Forces Institute, which since World War II has been providing study opportunities and tests of various kinds to personnel, is now being closed out as a result of Congressional action. This is shifting educational responsibility to the various services where vigorous new programs are emerging: The Air Force has established its own accredited community college; the Army and Navy are organizing consortia of colleges and universities to provide study opportunities. Overall encouragement is being provided at the Defense Department level under the label of the Voluntary Education Program, and budgetary support for education is rising.
- A rapidly expanding program is the Servicemen's Opportunity College, through which service personnel establish permanent ties with a participating college or university, earning credit through on-post courses, examination, military training courses, and experience. This effort began only last year, centered in community colleges. Four-year institutions are now affiliating, and the forthcoming catalog will list 121 baccalaureate institutions among the total of some 250. The emphasis is on vocational/technical and professional programs. Many of the four-year institutions offer engineering in their regular programs, and servicemen have the opportunity to take basic and pre-engineering courses in the service and

to continue on to engineering school as veterans under the GI Bill.

- Since World War II the American Council on Education has been publishing a guide which evaluates military training courses for college credit. This guide is now being updated and revised to include credit for military work experience, which will provide a big boost for veterans who wish to continue their education following discharge.
- The Army is testing out in two states arrangements under which a recruit is enrolled in a college at the time of his enlistment, and accumulates credit on his transcript for academic work, and military training and experience, while in service. He can then return to full time college study after earning up to two years of college credit during a three-year hitch. Individual institutions have seen the value of this type of program and several have set up similar arrangements in cooperation with recruitment operations.
- Great emphasis is being placed on vocational/technical programs of study directed primarily to A.A. degrees. Extending this thrust to include the B.S. in engineering as an achievable target is a natural outgrowth of the current effort, adding a high-level option to in-service students.

Current developments certainly argue for a vigorous effort to work out armed forces programs that further our goal. Close coordination would yield at least two major advantages:

1. Access to a large pool of potential engineers. These are young people who will be receiving the encouragement and support of the defense apparatus, and training which develops skills essential to engineering education. Among them there should be many with the abilities and the motivation to move toward engineering careers.
2. Financial relief to our program through the assumption of living costs and most tuition payments by the services and the Veterans Administration during the period of active duty; and through GI Benefits for continued study after discharge. Each engineering student from this source would save our program the $3,500 to $4,500 we figure it would take to produce a minority B.S. in engineering.

Thus, we recommend that engineering educators and the Coordinating Committee devote early and energetic effort to working with the Department of Defense and the several armed forces to develop educational programs that will permit service men and women to get into the stream of engineering education.

In addition to opportunities for attracting service personnel into engineering there is, within the military, an additional pool of potential engineers that should not be overlooked. These are the children of service personnel who attend dependents' schools. They number over 160,000, and some 4,600 graduate from high school each year. These young people can be reached through a natural extension of any recruiting program directed toward those in uniform. We would urge that any effort directed toward the armed forces be extended to include Department of Defense dependents' schools.

Federal Programs for Disadvantaged Students

The United States Office of Education (OE) is authorized and funded to conduct three programs intended to help disadvantaged students obtain the benefits of a post-secondary education. Known collectively as the Special Programs for the Disadvantaged, they are:

Talent Search: to identify students of exceptional potential and assist them to enter college and finance their education and to help school and college dropouts to reenter the system

Upward Bound: summer in-residence programs on college campuses, with appropriate follow-up for students characterized as under-achievers, and in need of improved skills and motivation if they are to pursue a post-secondary education successfully

Special Services: remedial and supportive programs for students enrolled in or accepted by post-secondary institutions, conducted within the institutions

The above descriptions, as well as the generalizations that follow, apply to most of the projects funded under the programs. There are exceptions, and experimental variations, that may prove important to our program.

Each program operates by making support grants to operating agencies, which are usually post-secondary institutions or specialized agencies serving the needs of disadvantaged programs. These range between $60,000 and $250,000 annually, with an average of about $100,000. Grants are made in response to formal proposals, with priority given to continuing programs that have demonstrated their effectiveness.

The current policy of the OE is to support programs that are not discipline-oriented. Some specialized programs have been supported in the past, (notably an engineering Upward Bound program at Oakland University), but not encouraged, since regulations require that participants be given a wide range of career opportunities. However, it is possible that OE might be open to the development of pilot projects under our program, jointly supported by federal and private funds.

These programs are currently (FY '74) funded at an annual level of over $67 million, and support has been rising, especially in Upward Bound and Special Services. The breakdown is as follows:

Talent Search–$6 million
Upward Bound–$38.331 million
Special Services–$23 million

These amounts are considered to be trivial and inadequate by OE personnel. So far as our program is concerned, given the present policy which opposes specialized projects such as those aimed at engineering, we should expect help at least in proportion to the level of engineering enrollments in the total post-secondary system.

Following is a rundown on these programs which provides some idea of range, magnitude, and opportunities for our program:

Talent Search. About 90 projects are currently funded, selected from 200–250 applications yearly. Most of the projects are located in social service, community agencies and universities.

These agencies actively recruit promising students, provide counseling, and assist in lining up financial aid. Project directors attend regional meetings at which they coordinate their activities and exchange information. The agencies which carry out our search for engineering talent would be well advised to tie into these regional meetings and promising individual projects.

Upward Bound. Some 350 regular summer residential programs and 67 special Veterans Programs of six to eight weeks now serve about 27,500 students per year. The target population is under-achieving high school students completing their sophomore year. About three-fourths of the students are members of minority groups under our definition. Over 100,000 have participated since the program's inception in 1965, 78.6% of them have entered college, and 57% have graduated from college or are still in college.

The academic program generally concentrates on math and English during each of the three summers of a complete program. Project personnel are expected to follow up with students during the regular academic year, but this has not proved to be easy or effective.

In addition to the regular program for secondary level students, Congress has recently provided funds for projects to serve veterans in need of remediation prior to entry into college.

Costs of Upward Bound summer programs average about $1,350 per student per year; including all expenses, from instruction to room, board and personal needs.

Evaluations of the program and judgments as to its effectiveness are mixed and a recent critical evaluation by the General Accounting Office casts its future in some doubt. Some feel that it falls short of the mark since its students don't do very well in college. The length of the summer sessions are considered by some to be too short to be effective; they feel that 12 weeks would be preferable. The program may also be suffering as a result of being shifted from the Office of Economic Opportunity (OEO), where it began, to OE, where commitment to it is lower.

Our program could relate to Upward Bound in two notable ways. First, by encouraging prospective engineering students to take part and by seeking recruits to engineering from among the participants. Second, our effort could take advantage of the opportunity to set up pilot Upward Bound projects with joint support from government and private sources. Such projects could probably be devoted to developing skills necessary for success in engineering, despite the general policy which opposes special purpose projects.

Special Services for Disadvantaged Students. Initiated in 1970, this program operates through about 200 projects in colleges and universities, selected from some 600 proposals made each year. The services provided are remedial tutoring and supportive counseling for students at the project institution.

Most projects are open to students in all fields. A notable exception is the

UC/Berkeley Graduate Minority Program-Science Project which serves graduate students in the sciences.

By legislative provision, most of Special Services projects are in higher education institutions since the student must be enrolled or accepted for enrollment at the institution which has received the grant. It is doubtful that our program could benefit substantially from this program except for counseling efforts to serve engineering students who might qualify under the regulations, but proposals for funds for such purposes would be up against substantial competition.

Alternative and Ethnically Controlled Private Schools

Besides the military and federal programs just discussed there are in several minority communities groups who have been so poorly served by the public school system that they have founded their own schools and "street academies." Some, such as Harlem Prep in New York and Nairobi Schools in California, have generated national interest. One approach of these schools, which have proved successful in motivating disadvantaged youth who have been "turned off" by conventional curricula, is to develop work- and profession-oriented curricula and to involve peer and family groups in the teaching and counseling programs. These schools are small and involve only a small portion of the minority youth, but because of the schools' high visibility their approaches often influence the neighboring public school establishments which are anxious to not be embarassed by their poor neighbors' better performance. There may be some merit in encouraging several of these experimental schools to emphasize the economic opportunities available for minorities in engineering and to devise engineering curricula at the high school level. Besides the heightened awareness of engineering such programs would produce in the minority community and local public school system, they would, if successful, provide models for increasing the size of the academically oriented minority pool.

Professional Societies and Community Organizations

The Task Force is aware of two redemptive programs which seek out and train undereducated, underemployed minority youth for careers as draftsmen and technicians: 1) the Engineering Societies Committee for Manpower Training (ESCMT) in San Francisco, and 2) the Joint Urban Manpower Program (JUMP) in New York City. Working in conjunction with community organizations such as the Urban League, these programs identify, counsel and place minorities in on-the-job training programs which they staff for local industries. By maintaining close and cordial relations with their trainees beyond the training and technical employment probationary period, these programs encourage those who demonstrate academic aptitude to continue their studies at

the college level in after-hours courses. Technicians and draftsmen have traditionally provided a pool of engineering students (usually part-time) and in any event, raise the technological awareness of the community with corresponding long-range benefits for engineering recruiting. Such programs should be encouraged and supported by the engineering profession.

6

The Price Tag for Progress

In considering the cost of increasing minority enrollments in engineering there are two distinct categories:

1. The cost of financial aid required *by* the added students, and
2. The cost to institutions and organizations for support programs, including such items as identification, recruitment, tutorial work, etc.

These will be considered separately here.

STUDENT NEED

The need to provide financial assistance to students is unquestioned if we are to achieve an increase in minority engineering enrollments. Even if other barriers—cultural, educational, informational—are removed, a large proportion will require assistance, as Table 6-1 clearly demonstrates.

While Column 3 of Table 6-1 is for U. S. Blacks only, other sources indicate that the other underrepresented minorities are also economically deprived. For example, in 1972, the median income of families of Chicanos and Puerto Ricans was $7,908 and $7,613, respectively, compared to $11,549 for white families and $7,106 for "Negro and other races."[1] Column 5 of Table 6-1 shows that even those minorities now enrolled in college fall well below the income level of the overall population and cannot rely on much of any family help according to the guidelines of the College Scholarship Service (CSS) of the College Entrance Examination Board, American College Testing Service, and federal agencies.

Beyond the need for student support as determined by standard formulas, there is strong support for the argument that minority students need extra sums in order to cross cultural barriers. Estimates of this need range from $35 per month "for supplementary services" to $500 per year "for very low income students for such extra personal expenses as adequate clothing."[2]

TABLE 6-1

Family Income Distribution, 1971

	U.S. POPULATION AS A WHOLE	U.S. BLACKS	ALL FRESHMEN IN ALL COLLEGES	MINORITY FRESHMEN IN ALL COLLEGES
	(2)	(3)	(4)	(5)
below $6,000	24.2%	46.9%	12.0%	43.9%
$6,000–$9,999	24.0%	25.4%	22.4%	27.7%
$10,000–$14,999	26.9%	17.2%	32.3%	17.3%
$15,000 and over	24.8%	10.6%	33.3%	11.0%

SOURCES: Columns 2 and 3: U. S. Department of Commerce, Bureau of the Census, *Money Income in 1971 of Families and Persons in the United States*, Current Population Reports, Series P-60, No. 85 (Washington, D.C., December 1972), Table 16, pp. 40–41.

Column 4: *The American Freshman: National Norms for Fall 1971* (Washington, D.C.: American Council on Education, 1971).

Column 5: Alan E. Bayer, *The Black College Freshman* (Washington, D.C.: American Council on Education, 1972), p. 39 (1971 data). Figures are national norms for Blacks only, but a survey by Bayer in the same source (p. 85) of Chicanos, Puerto Ricans and American Indians indicates that the patterns for the other underrepresented minorities are similar.

Caveats

Computation of projected student financial aid requirements is an extraordinarily complex and risky business. All kinds of sources of funding must be predicted, and in some cases merely guessed at. The family income levels and resources of students who will be attracted is uncertain. Costs at various kinds of institutions vary greatly. The mix of institutions that minorities will be attending is hard to predict and will be determined in large part by the amount of financial aid available through each.

In order to keep student cost computations as simple as possible, they are developed here entirely on a per-student basis. Later extension by target numbers will yield an indication of overall costs. But in developing these per-student costs we are required to make a number of limitations and assumptions. We spell these out in detail so readers can properly interpret our findings, and so that adjustments can be made if some of the anticipated assumptions change. We assume that:

1. **We are dealing here exclusively with added engineering students in college, to be supported by new funds.** Present enrollment levels will continue to be supported as they are at present.
2. The institutions with colleges of engineering that we have selected for

analysis—chosen because they produce, or are so located that they could produce, the largest numbers of minority engineers—are representative of all institutions in their classes at which new minority students are likely to enroll. The three classes are: predominantly white public, predominantly white private, and predominantly black colleges and universities.

3. Added minority students will have the same general characteristics (in terms of their living arrangements, personal family situations, etc.) as the students presently enrolled in the sample of institutions.
4. Added students will be regular full-time students.
5. Added students at public institutions will not cross a state line to attend engineering school.
6. Student budgets (which include tuition, living expenses, books, and other necessary costs of attendance), as published by CSS and verified by us with financial aid offices at each of the 30 representative institutions, are realistic statements of the total cost of going to college.
7. For the next two years, student costs will increase seven per cent per year, (which corresponds to the rate of change at four-year public institutions between 1973-74 and 1974-75 reported by CSS), and expected family contributions to the cost of education will rise at the same rate.
8. Student costs will not rise after 1975-76. We obviously don't really believe this, but use it as a device to make a long-range projection on the basis of constant dollars. To do otherwise, that is to build in the compounding effects of inflation, would produce unrealistic figures: most people are not capable of thinking in terms of the dollar eroded by eight or ten years of continuing inflation. At the end of this section we show total costs of the program in both constant and inflated dollars.
9. Federal government aid to students, in the form of Basic Educational Opportunity Grants (BOG) and Supplementary Educational Opportunity Grants (SOG), will reach a level of $1,000 for new students with full need in 1974-75; BOG's, provided for in the Higher Education Ammendments of 1972, and recommended for full funding in 1975-76 by the administration budget, will indeed be fully funded in that year, providing up to $1,400 per needy student; and full funding will continue, and the $1,400 ceiling will rise in proportion to inflationary increases in ensuing years.
10. A reasonable goal of educational planning is the provision of maximum access and free choice. But when real financial limitations arise, the best course is to yield somewhat on free choice in order to maximize access. We propose a doubling of engineering enrollments in predominantly Black colleges, as a short-term (5 year) goal, from the present level of about 2,000, since these colleges are in a position to expand rapidly. Following this period of rapid growth, the Black college enrollments should taper off to reflect normal growth patterns commensurate with their new enrollment base. The remainder of the minority enrollment

TABLE 6-2

Student Budgets: Single Students

Selected Predominantly Black Institutions

INSTITUTION	RESIDENT BUDGET 1974-75	COMMUTER BUDGET 1974-75	PER CENT RESIDENT 1973-74	WEIGHTED (BY RESIDENCE) AVERAGE BUDGET	UNDERGRADUATE ENGINEERING ENROLLMENT FULL-TIME 1973-74
Howard	$3104	$1868	25%	$2177	446
No. Car. A & T	1700	1650	72%	1686	314
Prairie View	2822	1924	98%	2804	341
Southern	1460	1260	50%	1360	218
Tenn. State	1706	1201	34%	1373	217
Tuskegee	2600	2200	52%	2408	250
TOTAL					1786
Weighted (by enrollment) Average Budget—1974-75				$2045	
Projected Budget—1975-76 @ 7% increase				$2188	

TABLE 6-3

Student Budgets: Single Students

Selected Public Universities

INSTITUTION	RESIDENT BUDGET 1974-75	COMMUTER BUDGET 1974-75	PER CENT RESIDENT 1973-74	WEIGHTED (BY RESIDENCE) AVERAGE BUDGET	UNDERGRADUATE ENGINEERING ENROLLMENT FULL-TIME 1973-74
U. of Alabama	$2200	$1990	85%	$2169	629
U. of Cal/Berkeley	3290	2440	82%	3137	1545
CUNY	--	2324**	0%	2324	1394
U. of Ill/Chicago Circle	--	2500	0%	2500	1837
U. of Ill/Urbana	2596	2596	98%	2596	3431
Cal State U./L.A.	--	2985**	0%	2985	347
U. of Michigan	3250	3250	NA	3250	2730
Mich. Tech. U.	2596	2170	60%	2426	1945
U. of Missouri/Rolla	2520	2370	99%	2519	2388
Newark Col. of Eng.	3980	2700	0%	2700	2131
New Mexico State U.	2380	2580	100%*	2380	861
U. of North Dakota	2100	--	100%*	2100	338
Ohio State Univ.	2900	2200	70%	2690	2334
Purdue	2650	2230	100%	2650	4681
U. of Texas/El Paso	2453	2303	109%*	2453	762
Wayne State Univ.	--	2432	0%	2432	941
TOTAL					28,294
Weighted (by enrollment) Average Budget—1974-75				$2649	
Projected Budget—1975-76 @ 7% increase				$2834	

*100% resident assumed since data not available; most students, especially minorities, are likely to be in residence, or difference between resident and commuter is minor (UTEP, NMSU).

**Weighted average of various categories.

increase should then be in a mix of private and public institutions, at about the same ratio (30%–70%) as their present output of BS degrees in engineering. This we recommend despite the added cost because we believe there is real value to maintaining the present mix in engineering education.

Student Costs

Tables 6-2, 6-3, and 6-4 report on student budgets at the three classes of institutions we are concerned with. Those selected for analysis were representative of major engineering institutions in each category now enrolling (or likely to enroll under the impetus of the program) substantial numbers of minority students. The key figures are those for the "base year" of 1975-76: total student needs per year of:

$2,188 at predominantly Black colleges
$2,834 at public universities
$5,140 at private universities.

In Tables 6-5, 6-6, and 6-7 we develop weighted average student need figures based on the above budgets, expected parental contributions, and federal support programs as stipulated in our criteria. These show average requirements for student support after expected federal aid grants (which are expected to rise in this period) as follows:

1974–75	1975–76	
$673	$702	at predominantly Black colleges
$1129	$937	at public universities
$3080	$2983	at private universities.

The above figures take no account of students' earnings, which CSS and

TABLE 6-4

Student Budgets: Single Students

Selected Private Institutions

INSTITUTION	RESIDENT BUDGET 1974-75	COMMUTER BUDGET 1974-75	PER CENT RESIDENT 1973-74	WEIGHTED (BY RESIDENCE) AVERAGE BUDGET	UNDERGRADUATE ENGINEERING ENROLLMENT FULL-TIME 1973-74
Cornell	$5600	--	100%	$5600	2255
Drexel	4150	$3300	47%	3700	1547
Poly. Inst. N.Y.	4900	4250	29%	4439	1151
R.P.I.	5300	4300	60%	4900	1697
U. So. Calif.	5779	3779	50%	4779	522
Stevens I.T.	4815	3965	80%	4645	870
Tufts	5500	4000	90%	5350	642
Wash. U./S. L.	5400	4050	51%	4739	519
TOTAL					9203
Weighted (by enrollment) Average Budget—1974-75				$4803	
Projected Budget—1975-76 @ 7% increase				$5140	

TABLE 6-5

Student Need

Minorities in Predominantly Black Colleges

1974–75

FAMILY INCOME BRACKET	EXPECTED PARENTAL CONTRIBUTION	NET NEED	% IN BRACKET	WEIGHTED NEED COMPUTATION* (3) × (4)	NEED AFTER FEDERAL AID OF $1,000	WEIGHTED NEED COMPUTATION** (6) × (4)
	(2)	(3)	(4)	(5)	(6)	(7)
0–5,999	0	$2045	50.4%	$1031	$1045	$527
6,000–7,999	$ 165	1880	12.1%	227	880	106
8,000–9,999	632	1413	9.6%	136	413	40
10,000–12,499	1182	863	9.6%	83	0	0
12,500–14,999	1775	270	5.9%	16	0	0
15,000–19,999	3005	0	4.9%	0	0	0
20,000–24,999	5168	0	3.4%	0	0	0
25,000 +	5128+	0	4.0%	0	0	0
Weighted Average Need per Student:						
*Before Federal Aid				$1493		
**After Federal Aid						$673

1975–76

FAMILY INCOME BRACKET	EXPECTED PARENTAL CONTRIBUTION	NET NEED	% IN BRACKET	WEIGHTED NEED COMPUTATIONS* (3) × (4)	NEED AFTER FEDERAL AID OF $1,094	WEIGHTED NEED COMPUTATION** (6) × (4)
	(2)	(3)	(4)	(5)	(6)	(7)
0–5,999	0	$2188	50.4%	$1104	$1094	$551
6,000–7,999	$ 176	2012	12.1%	244	918	111
8,000–9,999	677	1511	9.6%	145	417	40
10,000–12,499	1265	923	9.6%	89	0	0
12,500–14,999	1899	289	5.9%	17	0	0
15,000–19,999	3215	0	4.9%	0	0	0
20,000–24,999	5530	0	3.4%	0	0	0
25,000 +	5530+	0	4.0%	0	0	0
Weighted Average Need per Student:						
*Before Federal Aid				$1599		
**After Federal Aid						$702

NOTES: Col. 2: 1973–74 figures for family of four escalated 7% each year.

Col. 3: Net need = Student budget (from Table 6-2: $2045 in 1974–75 and $2188 in 1975–76) less expected family contribution from Col. 2.

Col. 4: *The American Freshman: National Norms for Fall 1973* (Washington, D.C.: American Council on Education, 1973), p. 42.

TABLE 6-6

Student Need

Minorities in Public Universities

1974–75

FAMILY INCOME BRACKET	EXPECTED PARENTAL CONTRIBUTION	NET NEED	% IN BRACKET	WEIGHTED NEED COMPUTATION* (3) × (4)	NEED AFTER FEDERAL AID OF $1,000	WEIGHTED NEED COMPUTATION** (6) × (4)
	(2)	(3)	(4)	(5)	(6)	(7)
0–5,999	0	$2649	43.9%	$1163	$1649	$724
6,000–7,999	$ 165	2484	15.9%	395	1484	236
8,000–9,999	632	2017	11.8%	238	1017	120
10,000–12,499	1182	1467	10.4%	153	467	49
12,500–14,999	1775	874	6.9%	60	0	0
15,000–19,999	3005	0	5.6%	0	0	0
20,000–24,999	5168	0	2.6%	0	0	0
25,000 +	5168+	0	2.8%	0	0	0
Weighted Average Need per Student:						
	*Before Federal Aid			$2009		
	**After Federal Aid					$1129

1975–76

FAMILY INCOME BRACKET	EXPECTED PARENTAL CONTRIBUTION	NET NEED	% IN BRACKET	WEIGHTED NEED COMPUTATION* (3) × (4)	NEED AFTER FEDERAL AID OF $1,400	WEIGHTED NEED COMPUTATION** (6) × (4)
	(2)	(3)	(4)	(5)	(6)	(7)
0–5,999	0	$2834	43.9%	$1244	$1434	$630
6,000–7,999	$ 176	2658	15.9%	423	1258	200
8,000–9,999	677	2157	11.8%	255	757	89
10,000–12,499	1265	1569	10.4%	163	169	18
12,500–14,999	1899	935	6.9%	65	0	0
15,000–19,999	3215	0	5.6%	0	0	0
20,000–24,999	5530	0	2.6%	0	0	0
25,000 +	5530+	0	2.8%	0	0	0
Weighted Average Need per Student:						
	*Before Federal Aid			$2150		
	**After Federal Aid					$937

NOTES: Col. 2: 1973–74 figures for family of four, escalated 7% per year.

Col. 3: Net need = Student budget from Table 6-3: $2649 in 1974–75 and $2834 in 1975–76) less expected family contribution from Col. 2.

Col. 4: Alan E. Bayer, *The Black College Freshman* (Washington, D.C.: American Council on Education, 1972). These data are for 1971–72 Black freshmen only, but the patterns for other underrepresented minorities are similar, and we assume the same relative distribution is approximated through 1975–76.

TABLE 6-7

Student Need

Minorities in Private Universities

1974–75

FAMILY INCOME BRACKET	EXPECTED PARENTAL CONTRIBUTION	NET NEED	% IN BRACKET	WEIGHTED NEED COMPUTATION* (3) × (4)	NEED AFTER FEDERAL AID OF $1,000	WEIGHTED NEED COMPUTATION** (6) × (4)
	(2)	(3)	(4)	(5)	(6)	(7)
0–5,999	0	$4803	43.9%	$2109	$3803	$1670
6,000–7,999	165	4638	15.9%	737	3638	578
8,000–9,999	632	4171	11.8%	492	3171	374
10,000–12,499	1182	3621	10.4%	377	2621	273
12,500–14,999	1775	3028	6.9%	209	2028	140
15,000–19,999	3005	1798	5.6%	101	798	45
20,000–24,999	5168	0	2.6%	0	0	0
25,000 +	5168+	0	2.8%	0	0	0
Weighted Average Need per Student:						
*Before Federal Aid				$4025		
**After Federal Aid						$3080

1975–76

FAMILY INCOME BRACKET	EXPECTED PARENTAL CONTRIBUTION	NET NEED	% IN BRACKET	WEIGHTED NEED COMPUTATION* (3) × (4)	NEED AFTER FEDERAL AID OF $1,400	WEIGHTED NEED COMPUTATION** (6) × (4)
	(2)	(3)	(4)	(5)	(6)	(7)
0–5,999	0	$5140	43.9%	$2256	$3740	$1642
6,000–7,999	$ 176	4964	15.9%	789	3564	567
8,000–9,999	677	4463	11.8%	527	3063	361
10,000–12,499	1265	3875	10.4%	403	2475	257
12,500–14,999	1899	3241	6.9%	224	1841	127
15,000–19,999	3215	1925	5.6%	108	525	29
20,000–24,999	5530	0	2.6%	0	0	0
25,000+	5530+	0	2.8%	0	0	0
Weighted Average Need per Student:						
*Before Federal Aid				$4307		
**After Federal Aid						$2983

NOTES: Col. 2: 1973–74 figures for family of four escalated 7% each year.

Col. 3: Net need = Student budget (from Table 6-4: $4802 in 1974–75 and $5140 in 1975–76) less expected family contribution from Col. 2.

Col. 4: Alan E. Bayer, *The Black College Freshman* (Washington, D.C.: American Council on Education, 1972). See footnote to Table 6-6.

other similar bodies project at around $500 per summer; other projections also assume some level of student earnings during the academic year. We propose, in these computations, to place minimal reliance on student earnings, and do not count on any student contribution during the first year, in keeping with our discussion of this topic in Chapter 5.

We do expect self-help contributions, in the form of work or loans, from students above the freshman level. These sums are taken into account later in this chapter as offsets to financial aid costs in Tables 6-13.

TOTAL MINORITY ENROLLMENT

In order to determine the total cost of financial aid in our proposed program, and to determine other costs as well, it is necessary to project total minority engineering enrollments year by year, by class level.

Chapter 4 proposed enrollment targets for incoming freshman classes necessary to achieve our ultimate goal of minority parity in engineering. Here we project these figures into subsequent classes, making the assumption that minority students will have at least the same rate of survival as all engineering students have experienced over the past few years (indeed, this is a further goal of our program).

Table 6-8 develops these norms, using incoming freshmen at engineering schools as the base number. Those who transfer into engineering from other programs, including transfers from pre-engineering in two-year colleges, partially replace those who drop out, thus accounting for the apparent low rate of attrition among students in the junior year. We assume that minority students who transfer into engineering will come within our program and thus we use the overall net year-to-year enrollment ratios as the basis of our projection.

The apparent increase in the senior year is most likely the result of some fifth (and above) year students being classified as seniors for record purposes. This distortion is consistent with our finding reported in Chapter 3 that time to completion of a BS in engineering is close to five years of full-time study.

In brief, Table 6-8 shows that, based on the average experience in recent years, for every 100 freshmen who enter engineering colleges, there will be in those colleges:

71.5 sophomores one year later
65.9 juniors two years later
67.0 "seniors" three years later
5.7 fifth year students four years later.

These are the class level distribution rates we apply to arrive at the total minority enrollments in Tables 6-9. These are the figures we shall use in calculating aid needs and offsets, and the cost of special student support programs.

Tables 6-10 distribute the enrollment increase among the three classes of institutions, again, assuming that the predominantly Black colleges will double their engineering enrollments over the next five years before leveling off to

TABLE 6-8

Class Level Distribution for Engineering Students

YEAR OF ENTRY (YEAR N)	ENTERING FRESHMEN	SOPHOMORES YEAR N + 1	JUNIORS YEAR N + 2	SENIORS YEAR N + 3	5TH YEAR STUDENTS YEAR N + 4
1967	77,551	55,615	50,039	51,983	4,391
		71.7%	64.5%	67.0%	5.6%
1968	77,484	52,972	49,855	51,377	4,586
		68.4%	64.3%	66.3%	5.9%
1969	74,113	53,419	48,543	49,895	4,222
		72.1%	65.5%	67.3%	5.7%
1970	71,661	47,948	45,874	48,366	--
		66.9%	64.0%	67.5%	--
1971	58,566	42,272	41,673	--	--
		72.2%	71.2%		
1972	52,100	40,519	--	--	--
		77.7%			
Average Enrollment Ratios		71.5%	65.9%	67.0%	5.7%

NOTE: Numbers are full-time enrollments. Per cent figures are the percentage of the original freshman enrollment in subsequent years.

SOURCE: *Engineering and Technology Enrollments*—an annual publication of Engineering Manpower Commission of Engineers Joint Council.

more normal growth patterns thereafter, and that the remainder of the expansion will be divided 70-30 between public and private institutions.

GROSS FINANCIAL AID COSTS

Tables 6-11 extend total student financial aid need for the additional students under the enrollment assumptions we have made, and before taking account of offsets such as existing aid programs and student self-help. The extensions show that the gross financial aid requirements for the year 1974-75 will be at out $1.9 million, and that by 1982-83 they will range between $32.5 million and $49.2 million yearly, depending on whether growth in engineering follows our "conservative" or "optimistic" projections developed in Chapter 4. The 1982-83 figures represent a "steady state" cost which will continue into the future.

Note that these and earlier computations make no special allowance for students who might attend pre-engineering programs in two-year community colleges: it is our assumption that students at such institutions will manage as they do now, and that they will become a responsibility of our program when they transfer into regular engineering programs.

Tables 6-11 show that the total gross financial aid cost of the proposed program will amount to between $151 and $221 million over the next nine years under our assumed distribution among institutions. Recall also that these are "constant dollars"—essentially 1975 dollars—with no built-in inflation factor.

These computations do not allow for some special programs that would reduce the gross cost of student aid. Among these are:

1. *Entitlement funds* such as those from the Veterans Administration, Vocational Rehabilitation funds, Social Security and the like. Such entitlements are independent of student need formulas, and could reduce aid requirements materially.
2. *Co-op education programs* in which students divide their annual calendars between work (hopefully related to career goals) and study. Some reduction in required aid as a result of co-op programs can be expected, but we hesitate to place much stress on them because only a small number of engineering students have access to co-op arrangements. (If the proportion of co-op students rises above the present 12% or so [see p. 75], it can become an important element not only in financial aid but in sustaining motivation and opening career opportunities. Encouragement of co-op programs should be a function of our program effort.)
3. *State financial aid funds.* We take these into account when we consider offsetting of funds below.

OFFSETS TO FINANCIAL AID COSTS

Some sources of funds not previously taken into account will reduce the needs for new financial aid dollars. We have computed projections for the following:

State Scholarship Funds

The 38 states reporting comprehensive programs in 1973-74 (and these include all the large population states) expended $375,283,370 in that year. Projecting at the rate of increase for the preceding two years (18%) they should expend $443 million in 1974-75. Although state scholarship funds have been rising rapidly over the past few years, we assume that the 1974-75 rate will continue into the future, since the appearance of federal aid reduces the enthusiasm of state legislatures to increase their own aid programs.

We assume that 3 percent of this amount will go to the 3 percent of students in engineering nationally. This would yield $13,290,000 yearly for all engineers.

State aid is generally available to those under $12,500 per year in family income. Since a higher proportion of minority students fall in this category than the student population as a whole (82% vs. 52.5%), we have weighted this factor as shown in Tables 6-12, which display the computation of expected state aid for the increased number of students in our target population. The figures for expected state aid are also shown in column (1) of Tables 6-13.

TABLE 6-9A

Minority Engineering Enrollments by Level

Based on Conservative Projection

YEAR	FRESHMEN*	SOPHOMORES	TOTAL LOWER DIVISION	JUNIORS	SENIORS	5TH YEAR	TOTAL UPPER DIVISION	TOTAL ENROLLMENT
1973-74	2640	1490**	4130	1230**	1052**	66**	2348	6478
1974-75	3250	1888	5138	1373***	1250***	89***	2712	7850
1975-76	4100	2324	6424	1740	1396***	106***	3242	9666
1976-77	5100	2932	8032	2142	1769	118***	4029	12,061
1977-78	6200	3647	9847	2702	2178	150	5030	14,877
1978-79	7350	4433	11,783	3361	2747	185	6293	18,076
1979-80	8400	5255	13,655	4086	3417	234	7737	21,392
1980-81	9000	6006	15,006	4844	4154	291	9289	24,295
1981-82	9500	6435	15,935	5536	4925	353	10,814	26,749
1982-83	9807	6793	16,600	5931	5628	419	11,978	28,578

*From Table 4-6.

**Based on estimates of current minority enrollments by class derived from Engineering Manpower Commission data for Blacks × 1.33.

***Based on preceding year's enrollment continuing on at the expected level of class distribution.

TABLE 6-9B

Minority Engineering Enrollments by Level

Based on Optimistic Projection

YEAR	FRESHMEN*	SOPHOMORES	TOTAL LOWER DIVISION	JUNIORS	SENIORS	5TH YEAR	TOTAL UPPER DIVISION	TOTAL ENROLLMENT
1973-74	2640	1490**	4130	1230**	1052**	66**	2348	6478
1974-75	3250	1888	5138	1373***	1250***	89***	2712	7850
1975-76	4350	2324	6674	1740	1396***	106***	3242	9916
1976-77	6000	3110	9110	2142	1796	118***	4029	13,139
1977-78	8000	4290	12,290	2869	2178	150	5195	17,485
1978-79	10,000	5720	15,720	3954	2915	185	7054	22,774
1979-80	11,600	7150	18,750	5272	4020	248	9540	28,290
1980-81	12,500	8294	20,794	6590	5360	342	12,292	33,086
1981-82	13,100	8938	22,038	7644	6700	456	14,800	36,838
1982-83	13,500	9367	22,867	8238	7772	570	16,580	39,447

*From Table 4-7.

**Based on estimates of current minority enrollments by class derived from Engineering Manpower Commission data for Blacks × 1.33.

***Based on preceding year's enrollment continuing on at the expected level of class distribution.

TABLE 6-10A

Distribution of Added Minority Enrollments in Engineering

Conservative Projection

YEAR	TOTAL UNDERGRADUATES	TOTAL ADDED UNDERGRADUATES	TOTAL ADDED UNDERGRADUATES*		
			PRED. BLACK COLLEGES	PUBLIC INSTITUTIONS	PRIVATE INSTITUTIONS
1973-74	6478	BASE YEAR			
1974-75	7850	1372	400	680	292
1975-76	9666	3188	800	1672	716
1976-77	12,061	5583	1200	3068	1315
1977-78	14,877	8399	1600	4759	2040
1978-79	18,076	11,598	2000	6719	2879
1979-80	21,392	14,914	2100	8940	3874
1980-81	24,295	17,817	2200	10,872	4745
1981-82	26,749	20,271	2300	12,490	5481
1982-83	28,578	22,100	2400	13,670	6030

TABLE 6-10B

Distribution of Added Minority Enrollments in Engineering

Optimistic Projection

YEAR	TOTAL UNDERGRADUATES	TOTAL ADDED UNDERGRADUATES	TOTAL ADDED UNDERGRADUATES*		
			PRED. BLACK COLLEGES	PUBLIC INSTITUTIONS	PRIVATE INSTITUTIONS
1973-74	6478	BASE YEAR			
1974-75	7850	1372	400	680	292
1975-76	9916	3438	800	1847	791
1976-77	13,139	6661	1200	3823	1638
1977-78	17,485	11,007	1600	6585	2822
1978-79	22,744	16,266	2000	9986	4280
1979-80	28,290	21,812	2200	13,668	5944
1980-81	33,086	26,608	2400	16,826	7382
1981-82	36,838	30,360	2600	19,252	8508
1982-83	39,447	32,969	2800	20,878	9291

*Assumes that the predominantly Black colleges will double their present enrollment of about 2000 within five years, and that remaining growth will be divided 70% in public universities, 30% in privates. See text.

Foundations and Industry

Dickason[3] concludes that student financial aid funds from these sources is not now large, and there is little reason to expect a major change unless a new effort is mounted. Current rates of support for engineering students are estimated to still be at 1970-71 levels: $3.6 million annually from foundations and $670,000 annually from industry.[4] The amounts expected from these sources are shown in columns (2) and (3) of Tables 6-13. They were calculated by using the same factors as used in column (5) in Tables 6-12 applied to the annually estimated amounts.

Self-help by Students

We discussed in Chapter 5 the intention to place minimum reliance on student self-help, largely in view of the demands of the engineering curriculum. Yet with a gross need so large, it seems reasonable for benefitting students to bear some part of the burden. Thus we have calculated in Table 6-13 the amounts which added grant-aided students would be expected to earn (or borrow, if they prefer) toward the cost of their education. This we have set at $500 for each year after the freshman year.

To compute the total amount of financial support in the form of self-help which we may expect the minority students to provide, we use the post-freshman minority engineering enrollments shown in Tables 6-9. Not all of these students will have to provide self-help, however, since, as we saw in Tables 6-5, 6-6, and 6-7, some of them will have no need at all. From the tables we can estimate that, after receiving federal aid, about three-fourths of the minority students will be eligible for financial aid of more than $500. We may thus assume that only about 75 percent of the post-freshman students will be called upon to contribute $500 each in self-help. The total amount of expected self-help is then obtained by multiplying 75 percent of the added post-freshmen minority enrollments by $500, yielding the amounts reported in column (4) of Tables 6-13.

Private Universities' Student Financial Aid Contributions

In Chapter 5 we proposed that student grants from our program be limited to a maximum of $1,500 per year, a figure consistent with limits of other national scholarship programs. We noted that private institutions would have to come up with funds from their own sources if they are to meet full student need, which after federal and parental contributions averages $2983 per student from 1975-76 onward (see Table 6-7), and rises to as much as $3740 per year for the 44% of the students with family incomes below $6,000.

Even with a self-help contribution of $500 from each minority student, and assuming current levels of state scholarship and philanthropic contributions, a $1,500 grant from NESF may only cover about half of the students' expenses at

TABLE 6-11A

Financial Aid Needs of Additional Minority Engineering Students

Conservative Projection

	Predominantly Black Colleges			Public Institutions			Private Institutions			Total
YEAR	ADDED UNDER-GRADS	NEED PER STUDENT*	TOTAL NEED	ADDED UNDER GRADS	NEED PER STUDENT*	TOTAL NEED	ADDED UNDER-GRADS	NEED PER STUDENT*	TOTAL NEED	TOTAL NEED ALL INST. (MILLIONS)
1974-75	400	$673	$269,200	680	$1129	767,720	292	$3080	$ 899,360	$ 1.936
1975-76	800	702	561,600	1672	937	1,566,664	716	2983	2,135,828	4.264
1976-77	1200	702	842,400	3068	937	2,874,716	1315	2983	3,922,645	7.640
1977-78	1600	702	1,123,200	4759	937	4,459,183	2040	2983	6,085,320	11.668
1978-79	2000	702	1,404,000	6719	937	6,295,703	2879	2983	8,558,057	16.258
1979-80	2100	702	1,474,200	8940	937	8,376,780	3874	2983	11,556,142	21.407
1980-81	2200	702	1,544,400	10,872	937	10,187,064	4745	2983	14,154,335	25.886
1981-82	2300	702	1,614,600	12,490	937	11,703,130	5481	2983	16,349,823	29.668
1982-83	2400	702	1,684,800	13,670	937	12,808,790	6030	2983	17,987,490	32.481
										$151.208

*From Tables 6-5, 6-6, and 6-7.

TABLE 6-11B

Financial Aid Needs of Additional Minority Engineering Students

Optimistic Projection

	Predominantly Black Colleges			Public Institutions			Private Institutions			Total
Year	ADDED UNDER-GRADS	NEED PER STUDENT*	TOTAL NEED	ADDED UNDER-GRADS	NEED PER STUDENT*	TOTAL NEED	ADDED UNDER-GRADS	NEED PER STUDENT*	TOTAL NEED	TOTAL NEED ALL INST. (MILLIONS)
1974-75	400	$673	$269,200	680	$1129	$767,720	292	$3080	$ 899,360	$ 1.936
1975-76	800	$702	561,600	1847	937	1,730,639	791	2983	2,359,553	4.652
1976-77	1200	702	842,400	3823	937	3,582,151	1638	2983	4,886,154	9.311
1977-78	1600	702	1,123,200	6585	937	6,170,145	2822	2983	8,418,026	15.711
1978-79	2000	702	1,404,000	9986	937	9,356,882	4280	2983	12,767,240	23.528
1979-80	2200	702	1,544,400	13,668	937	12,806,916	5944	2983	17,730,952	32.082
1980-81	2400	702	1,684,800	16,826	937	15,765,962	7382	2983	22,020,506	39.471
1981-82	2600	702	1,825,200	19,252	937	18,039,124	8508	2983	25,379,364	45.244
1082-83	2800	702	1,965,600	20,878	937	19,562,686	9291	2983	27,715,053	49.243
										$221.178

*From Tables 6-5, 6-6, and 6-7.

TABLE 6-12A

Computation of Expected State Aid

Conservative Projection

YEAR	ESTIMATED* TOTAL ENGINEERING ENROLLMENT	ADDED MINORITY ENROLLMENTS	TOTAL STUDENTS ELIGIBLE FOR STATE AID (1) × 52.5%	ADDED MINORITY STUDENTS ELIGIBLE FOR STATE AID (2) × 82%	% MINORITY STUDENTS IN ELIGIBLE POPULATION (4) ÷ (3)	STATE AID TO ADDED MINORITY STUDENTS (5) × $13,290,000 (MILLIONS)
	(1)	(2)	(3)	(4)	(5)	(6)
1974-75	168,000	1372	88,200	1125	1.3%	$ .173
1975-76	165,000	3188	86,625	2614	3.0%	$ .399
1976-77	166,000	5583	87,150	4578	5.3%	$ .704
1977-78	168,000	8399	88,200	6887	7.8%	$1.037
1978-79	169,000	11,598	88,725	9510	10.7%	$1.422
1979-80	170,000	14,914	88,725	12,229	13.8%	$1.834
1980-81	170,000	17,817	89,250	14,610	16.4%	$2.180
1981-82	170,000	20,271	89,250	16,622	18.6%	$2.472
1982-83	170,000	22,100	89,250	18,122	20.3%	$2.698

*Derived from EMC data and projections of freshmen enrollments from Chapter 4.

TABLE 6-12B

Computation of Expected State Aid

Optimistic Projection

YEAR	ESTIMATED* TOTAL ENGINEERING ENROLLMENT	ADDED MINORITY ENROLLMENTS	TOTAL STUDENTS ELIGIBLE FOR STATE AID (1) × 52.5%	ADDED MINORITY STUDENTS ELIGIBLE FOR STATE AID (2) × 82%	% MINORITY STUDENTS IN ELIGIBLE POPULATION (4) ÷ (3)	STATE AID TO ADDED MINORITY STUDENTS (5) × $13,290,000 (MILLIONS)
	(1)	(2)	(3)	(4)	(5)	(6)
1974-75	168,000	1372	88,200	1125	1.3%	$ .173
1975-76	169,000	3438	88,725	2819	3.2%	$ .425
1976-77	176,000	6661	92,400	5462	5.9%	$ .784
1977-78	186,000	11,007	97,650	9026	9.2%	$1.223
1978-79	197,000	16,266	103,425	13,338	12.9%	$1.714
1979-80	208,600	21,812	109,200	17,886	16.4%	$2.180
1980-81	217,000	26,608	113,925	21,819	19.2%	$2.552
1981-82	224,000	30,360	117,600	24,895	21.2%	$2.817
1982-83	230,000	32,969	120,750	27,035	22.4%	$2.977

*Derived from EMC data and projections of freshmen enrollments from Chapter 4.

TABLE 6-13A

Net Added Student Financial Aid Needs of Program After Expected Financial Aid Support from Existing Sources and Student Self-Help (Millions)

Conservative Projection

YEAR	STATE* SCHOLARSHIP FUNDS	FOUNDATION* STUDENT AID FUNDS	INDUSTRY* STUDENT AID FUNDS	STUDENT** SELF-HELP	PRIVATE UNIV *** FINANCIAL AID CONTRIBUTION	TOTAL OFFSETS TO STUDENT AID COSTS (1) → (5)	TOTAL NEW FINANCIAL AID NEEDS (FROM TABLE 6-11A)	TOTAL NET FINAN. AID NEEDS [COLUMNS (7) − (6)]
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1974-75	$ .173	$ .047	$.009	$ .286	$ .450	$ .965	$ 1.936	$ .971
1975-76	.399	.108	.020	.648	1.068	2.243	4.264	2.021
1976-77	.704	.191	.036	1.171	1.961	4.063	7.640	3.577
1977-78	1.037	.281	.052	1.815	3.043	6.228	11.668	5.440
1978-79	1.422	.385	.072	2.583	4.294	8.756	16.258	7.502
1979-80	1.834	.497	.092	3.433	5.778	11.634	21.407	9.773
1980-81	2.180	.590	.110	4.296	7.077	14.253	25.886	11.633
1981-82	2.472	.670	.125	5.029	8.175	16.471	29.668	13.197
1982-83	2.698	.731	.136	5.600	8.994	18.159	32.481	14.322
	$12.919	$3.500	$.652	$24.861	$40.840	$82.772	$151.208	$68.436

*See Text.

**Assumes 75% of the added minority students will have need above $500 yearly, and will earn or borrow $500 per year during the years after the freshman year.

***One half of total unmet financial need at private institutions shown in Table 6-11A. See text.

TABLE 6-13B

Net Added Student Financial Aid Needs of Program After Expected Financial Aid Support from Existing Sources and Student Self-Aid (Millions)

Optimistic Projection

YEAR	STATE* SCHOLARSHIP FUNDS	FOUNDATION* STUDENT AID FUNDS	INDUSTRY* STUDENT AID FUNDS	STUDENT** SELF-HELP	PRIVATE UNIV.*** FINANCIAL AID CONTRIBUTION	TOTAL OFFSETS TO STUDENT AID COSTS (1)→(5)	TOTAL NEW FINANCIAL AID NEEDS (FROM TABLE 6-11B)	TOTAL NET FINAN. AID NEEDS [COLUMNS (7) − (6)]
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1974-75	$ .173	$ .047	$.009	$ .286	$ .450	$ .965	$ 1.936	$ .971
1975-76	.425	.115	.021	.648	1.180	2.389	4.652	2.263
1976-77	.784	.212	.040	1.238	2.443	4.717	9.311	4.594
1977-78	1.223	.331	.062	2.118	4.209	7.943	15.711	7.768
1978-79	1.714	.464	.086	3.340	6.384	11.988	23.528	11.540
1979-80	2.180	.590	.110	4.820	8.865	16.565	32.082	15.517
1980-81	2.552	.691	.129	6.281	11.010	20.663	39.471	18.808
1981-82	2.817	.763	.142	7.463	12.690	23.875	45.244	21.369
1982-83	2.977	.806	.150	8.291	13.858	26.082	49.243	23.161
	$14.845	$4.019	$.749	$34.484	$61.089	$115.187	$221.178	$105.991

*See text.

**Assumes 75% of the added minority students will have need above $500 yearly, and will earn or borrow $500 per year during the years after the freshman year.

***One half of total unmet financial need at private institutions shown in Table 6-11B. See Text.

one of the private schools. Thus the private schools will have to provide the remainder of the students' needs from other resources available to them.

A reasonable estimate and expectation is that the private institutions will furnish or somehow arrange for one-half of the unmet needs of their students and hence of the total need sums shown in the Private Institutions section of Tables 6-11. We apply this amount as another offset to the gross cost of the program, as shown in column (5) of Tables 6-13.

The private schools should be able to regard NESF as a source of sorely needed new scholarship funds, seeing their own contributions matched dollar for dollar, and providing increased access for minority students to this important sector of higher education.

NET NEW FINANCIAL AID NEEDS

Column (8) from Tables 6-13 shows the net need for new student financial aid funds under the two enrollment projection assumptions. Requirements for the nine years needed to reach our minority enrollment goals will range from $68 to $106 million.

We should point out that the total need reported in Tables 6-11—$151 million to $221 million—has been reduced to this lower level primarily through our expectation that the students themselves, and the private institutions, will contribute substantially to meeting the need. Student self-help is expected to produce from $25 million to $34 million, or about 16 percent of the total. Private institutions are looked to for from $41 million to $61 million, or some 27 percent of overall need.

OTHER COSTS

In addition to direct support to students, a number of additional services will have to be provided if we are to help identify, prepare and assist additional minority students in engineering. The institutions themselves can perform many of the necessary services, but they will need some new funding to pay for them and this must be considered part of the gross cost of our program.

Summer Tutorials

Once high school graduates are enrolled in the program, many of them will require tutorial work and special counseling, in order to offset educational deprivations and cultural barriers, if the attrition rate is to be held down. The first of these services should be a pre-matriculation tutorial program to provide brush-up or remedial work in mathematics, science and learning skills. We propose this be accomplished in summer-long programs just before matricula-

TABLE 6-14A

Cost of Summer Tutorials

Conservative Projection

YEAR	MINORITY FRESHMEN ENTERING ENGINEERING	SUMMER TUTORIAL STUDENTS – COLUMN (1) × 60%	COLUMN (2) × $800 = ANNUAL SUMMER TUTORIAL COST (MILLIONS)
	(1)	(2)	(3)
1974-75	3250	1950	$1.560
1975-76	4100	2460	1.968
1976-77	5100	3060	2.448
1977-78	6200	3720	2.976
1978-79	7350	4410	3.528
1979-80	8400	5040	4.032
1980-81	9000	5400	4.320
1981-82	9500	5700	4.560
1982-83	9807	5884	4.707

TABLE 6-14B

Cost of Summer Tutorials

Optimistic Projection

YEAR	MINORITY FRESHMEN ENTERING ENGINEERING	SUMMER TUTORIAL STUDENTS – COLUMN (1) × 60%	COLUMN (2) × $800 = ANNUAL SUMMER TUTORIAL COST (MILLIONS)
	(1)	(2)	(3)
1974-75	3250	1950	$1.560
1975-76	4350	2610	2.088
1976-77	6000	3600	2.880
1977-78	8000	4800	3.840
1978-79	10,000	6000	4.800
1979-80	11,600	6960	5.568
1980-81	12,500	7500	6.000
1981-82	13,100	7860	6.288
1982-83	13,500	8100	6.480

tion at cooperating institutions. We estimate that 60 per cent of entering students will require such tutorial help. We propose an expenditure of $800 per student for these tutorial "camps," including a stipend of at least $10 per week. This sum is expected to cover living expenses, instructional costs, and other necessary expenses.

The adequacy of this estimate is borne out by an analysis of costs in 37 summer programs, which reported costs, surveyed by David C. O'Bryant and reported in the April, 1974, *Engineering Education*. These programs had a wide range of costs per student per week, but the median cost was $100 and the arithmetic average $123. Figuring on eight week tutorial sessions, our estimate appears to be in the right range. These existing summer programs, initiated primarily by engineering schools, have well served both minority and non-minority students. They have demonstrated the value of such summer study for a great many students. We hope that sponsoring agencies such as the National Science Foundation will continue their support for existing programs, which our proposed effort will supplement.

On this basis, we can project the cost of the tutorial program by using earlier data on the number of freshmen required to sustain the program (we use here the *total* number of entering minority freshmen, instead of just increases over present numbers since: 1) There is no way of distinguishing between normally anticipated students and those added by our program; 2) The 60 percent factor in part allows for the kind of student already making his way into engineering; and 3) Current attrition rates indicate that present programs are inadequate and need to be made available to all minority students). These costs are shown in Tables 6-14.

Continuing Tutoring and Counseling

Once minority students start their engineering education, they will require special support services, especially during their early years in college. This is important in both human and economic terms since minority attrition rates in engineering run higher than the general population already, and they are likely to rise, unless positive steps are taken, since our program will draw in students who may be less well qualified than the current crop.

Much of the straight tutorial work can be done by student volunteers, but professional services will be required to coordinate and arrange this volunteer work and to provide special monitoring and counseling beyond what is already available. Dickason[5] estimates the need for one counselor-tutor-coordinator for each 200 lower division minority students, and an annual cost of $30,000 for salary and support per counselor. This calculates out to $150 per lower division minority engineering student and total costs will be as shown in Tables 6-15A and B.

TABLE 6-15A

Cost of Continuing Tutoring and Counseling

Conservative Projection

YEAR	TOTAL LOWER DIVISION MINORITY ENGINEERING STUDENTS (FROM TABLE 6-9A)	TOTAL ANNUAL COUNSELING TUTORIAL COST @ $150 STUDENT (MILLIONS)
1974-75	5138	$ .771
1975-76	6424	.964
1976-77	8032	1.205
1977-78	9847	1.477
1978-79	11,783	1.767
1979-80	13,655	2.048
1980-81	15,006	2.250
1981-82	15,935	2.390
1982-83	16,600	2.490

TABLE 6-15B

Cost of Continuing Tutoring and Counseling

Optimistic Projection

YEAR	TOTAL LOWER DIVISION MINORITY ENGINEERING STUDENTS (FROM TABLE 6-9B)	TOTAL ANNUAL COUNSELING TUTORIAL COST @ $150 STUDENT (MILLIONS)
1974-75	5138	$ .771
1975-76	6674	1.001
1976-77	9110	1.367
1977-78	12,290	1.844
1978-79	15,720	2.358
1979-80	18,750	2.813
1980-81	20,794	3.119
1981-82	22,038	3.306
1982-83	22,867	3.430

Recruitment and Facilitation

Every analysis of the task of attracting minorities into engineering has recognized the need to mount active programs to identify and attract promising students and to help them get into engineering. Estimating the cost of such an effort depends upon a clear specification of the way the work is to be carried out. Many existing agencies can be involved, but each of them will require new resources if they are to make a contribution beyond moral encouragement. Recruitment personnel, and ways to convey the message, will have to be provided, whether the job is to be done by a single agency or many.

Specifying costs is extremely difficult since there is so little to guide us. One of the few analogues is the COGME Program to recruit students into graduate business programs. It once employed four recruiters plus a support staff and has operated on sums in the $150,000 to $250,000 per year range—but the target numbers of students it sought is miniscule compared with our goal: 1,000 or so students as contrasted with an eventual 28,000 or more in engineering.

Our effort will require a minimum of 10 field recruiters plus a central staff of perhaps two professionals in order to bring together the forces to reach potential students at all levels. Using a rule-of-thumb estimate of $60,000 per professional to cover all costs, we are looking at annual expenditures of ($12 \times \$60{,}000$) $720,000 for recruitment.

Promotional materials such as publications, radio spots, films, etc. will be needed. Much of the creative work can be obtained gratis through such agencies as the Advertising Council, and industries might be counted on to help with production costs. Nevertheless, a staff of at least two professionals will be needed to carry out and oversee promotional programs and substantial sums will be needed for production. Using the same rule-of-thumb for staff, we estimate $120,000 for personnel and perhaps $300,000 for production and distribution.

The total identified thus far is ($720,000 + $120,000 + $300,000) $1,140,000 per year at the peak for our facilitating program. Some diminution in dollar requirements should be expected as initial production is completed, and we propose a schedule of expenditures for recruiting and facilitative activities as follows:

1974–75	$1,140,000
1975–76	1,140,000
1976–77	1,000,000
1977–78	800,000
1978–79	700,000
1979–80	600,000
1980–81	500,000
1981-82	400,000
1982–83	200,000

The sharp decline in the need forecast for the final few years reflects our expectation that as minority recruitment takes hold, the momentum of the

program will replace the need for active bush-beating for candidates. Financial aid, coupled with (by then better-informed) regular counseling mechanisms will attract sufficient participants.

Once the financial aid funds have been raised, they will have to be distributed to needy students through the institutions where they are enrolled. As we discussed in Chapter 5, the cost of computer matching services and management of financial aid will equal about five per cent of aid funds to be distributed. Taking five per cent of the net aid (from Column 8 of each of Tables 6-13A, B) yields the estimated fund management costs shown in Table 6-16.

TABLE 6-16

Cost of Financial Aid Management

(millions)

YEAR	CONSERVATIVE PROJECTION	OPTIMISTIC PROJECTION
1974-75	$ .049	$ .049
1975-76	.101	.113
1976-77	.179	.230
1977-78	.272	.388
1978-79	.375	.577
1979-80	.489	.776
1980-81	.582	.940
1981-82	.660	1.068
1982-83	.716	1.158

Early Age Motivation

In addition to the efforts we have outlined to channel advanced secondary students into engineering, there is the need to encourage younger students to think about engineering, to make the profession more attractive to minority youth.

The details of such a program are difficult to specify with any confidence. Needless to say, community support will have to be enlisted, and appropriate promotional materials prepared. We have assumed that such efforts would be a part of the activities of the staff we have previously specified and costed out.

It may well be, however, that in addition to such broad support programs, it will be necessary to mount some closely targeted efforts to achieve success. We may have to press to involve minority youngsters in programs that will lead

to engineering careers. Some of these currently exist, and can be expanded and strengthened to increase their effectiveness. We have in mind such efforts as those conducted by JETS and MITE (see Chapter 5). Others may have to be devised. To place a price tag on such efforts is most speculative. But in order to develop an order of magnitude amount, we propose consideration of two-week summer involvement programs for the junior high and early high school years as an effective device.

In order to increase minority freshmen enrollments in engineering from the present levels of 2,640 students in 1973-74, and an estimated 3,250 students for 1974-75 (see Tables 6-9), we will be calling for between 6,557 and 10,250 additional freshmen by the year 1982-83. To achieve such increases, it will probably be necessary to mount special recruitment programs for twice this number of students each year, and we assign a cost to these efforts of $200 per student, based on a summer program of two weeks duration, with all the amenities of tutorial programs discussed earlier in this chapter. This will require an expenditure of $400 per student entering engineering three years later. Such a recruitment effort would result in total costs as shown in Table 6-17—a sketchy estimate but one that will put this phase of the program in context with the total.

Fund-Raising Costs

Not considered thus far is the cost of supporting the fund-raising apparatus to make our program go. We have little to go by in estimating this part of the need. The cost of raising money ranges from as little as three per cent for prestigious universities in major campaigns, to as much as 90 percent of the total budget of some rather shaky social and health service agencies. But our effort is more unitary and targeted than those which seek support for diverse programs from a diverse constituency. We seek funds only for financial aid and support services, and must get most of our funds from industry and foundation sources. And we will not be providing staff support for a huge volunteer organization.

We have concluded that our best estimate of fund-raising costs will be developed by setting down what appears to be the necessary professional staffing for the job, and costing it out on our rule-of-thumb basis. Upon consulting with experienced fund raisers, and reviewing the experience of other minority professional education programs, we project the need for a staff of ten: one top level director, six field persons responsible for working with donors and key volunteers, two persons responsible for preparing written material including individually tailored proposals, and an administrative manager to handle records and to direct the support staff.

Using our rule of $60,000 per professional staff member we thus project an annual cost of $600,000 for obtaining necessary support. This staff should be built over about two years, and modified in accord with early experience.

TABLE 6-17

Cost of Early Age Recruitment Programs

	Conservative Projection		Optimistic Projection	
Year	ADDITIONAL FRESHMEN NEEDED 3 YEARS LATER*	COST @ $400 PER STUDENT ENROLLED (MILLIONS)	ADDITIONAL FRESHMEN NEEDED 3 YEARS LATER*	COST @ $400 PER STUDENT ENROLLED (MILLIONS)
1974-75	2950	$1.180	4750	$1.900
1975-76	4100	1.640	6750	2.700
1976-77	5150	2.060	8350	3.340
1977-78	5750	2.300	9250	3.700
1978-79	6250	2.500	9850	3.940
1979-80	6557	2.623	10,250	4.200
1980-81	6557	2.623	10,250	4.200
1981-82	6557	2.623	10,250	4.200
1982-83	6557	2.623	10,250	4.200

*From Tables 6-9: Numbers of Freshmen needed three years later less freshmen anticipated for Fall 1974.

Thus we project fund-raising costs of $300,000 during the first year, and $600,000 thereafter, with the hope and expectation that the total can be pared somewhat from these figures.

TOTAL NEED FOR NEW FUNDS

By combining the preceding cost estimates for Summer Tutorials (Tables 6-14), Counseling and Tutoring (Tables 6-15), Net Student Financial Aid (Table 6-13), Financial Aid Management (Table 6-16), Recruiting and Facilitation (page 172), Early Age Recruitment (Table 6-17), and Fund Raising (page 175), we can compute the overall additional funding requirements for the national minority engineering program. In Tables 6-18A and B, we summarize our estimate of the total amount of new funds—over and above the current levels provided by government, students, academic institutions, foundations, business and other sources—necessary to increase minority engineering freshmen enrollments to a parity level by 1982-83.

The new funding requirements presented in Tables 6-18A and B are expressed in millions of 1974-75 and 1975-76 dollars, without regard to continued inflation.

Under the "conservative" projection, the annual need for new funds rises to $25.658 million by 1982-83, with a total nine-year need of $149.072 million

TABLE 6-18A

Total New Funds Required for Program

Conservative Projection

(millions)

YEAR	SUMMER TUTORIALS	COUNSELING-TUTORING	NET STUDENT FINANCIAL AID	FINANCIAL AID MANAGEMENT	SUB-TOTAL*: COLLEGE LEVEL COSTS	RECRUITING ETC.	EARLY AGE RECRUITMENT	FUND RAISING	TOTAL
1974-75	$ 1.560	$ .771	$ .971	$ .049	$ 3.351	$1.140	$ 1.180	$ .300	$ 5.971
1975-76	1.968	.964	2.021	.101	5.054	1.140	1.640	.600	8.434
1976-77	2.448	1.205	3.577	.179	7.409	1.000	2.060	.600	11.069
1977-78	2.976	1.477	5.440	.272	10.165	.800	2.300	.600	13.865
1978-79	3.528	1.767	7.502	.375	13.172	.700	2.500	.600	16.972
1979-80	4.032	2.048	9.773	.489	16.342	.600	2.623	.600	20.165
1980-81	4.320	2.250	11.633	.582	18.785	.500	2.623	.600	22.508
1981-82	4.560	2.390	13.197	.660	20.807	.400	2.623	.600	24.430
1982-83	4.707	2.490	14.322	.716	22.235	.200	2.623	.600	25.658
	$30.099	$15.362	$68.436	$3.423	$117.320	$6.480	$20.172	$5.100	$149.072

*The sum of the first four columns.

TABLE 6-18B

Total New Funds Required for Program

Optimistic Projection

(millions)

YEAR	SUMMER TUTORIALS	COUNSELING-TUTORING	NET STUDENT FINANCIAL AID	FINANCIAL AID MANAGEMENT	SUB-TOTAL* COLLEGE LEVEL COSTS	RECRUITING ETC.	EARLY AGE RECRUITMENT	FUND RAISING	TOTAL
1974-75	$ 1.560	$ .771	$ .971	$ .049	$ 3.351	$1.140	$ 1.900	$ .300	$ 6.691
1975-76	2.088	1.001	2.263	.113	5.465	1.140	2.700	.600	9.905
1976-77	2.880	1.367	4.594	.230	9.071	1.000	3.340	.600	14.011
1977-78	3.840	1.844	7.768	.388	13.840	.800	3.700	.600	18.940
1978-79	4.800	2.358	11.540	.577	19.275	.700	3.940	.600	24.515
1979-80	5.568	2.813	15.517	.776	24.674	.600	4.200	.600	30.074
1980-81	6.000	3.119	18.808	.940	28.867	.500	4.200	.600	34.167
1981-82	6.288	3.306	21.369	1.068	32.031	.400	4.200	.600	37.231
1982-83	6.480	3.430	23.161	1.158	34.229	.200	4.200	.600	39.229
	$39.504	$20.009	$105.991	$5.299	$171.803	$6.480	$32.380	$5.100	$214.763

*The sum of the first four columns.

to achieve the goal. If engineering enrollments rise at the rate we have labelled as the "optimistic" projection, and if we are to achieve the same proportionate parity, the need for new funds will rise to an annual level of $39.229 million in the target year of 1982-83. Total needs over the nine years will then be $214.763 million.

These are large sums. So large that one is tempted to look to the federal government as a source of support. Special manpower programs have provided funds for training in a few fields, but it seems unlikely that new federal support can be counted on at a time when attention is being concentrated on obtaining full funding for the BOG program (which we have assumed will occur). The prospect of generating federal support should not be overlooked, and our program should press for increased federal support, but we do not rely on it in this report.

While the amounts of new funds which must be generated from the private sector are large, it is useful to observe that in April 1974 one single university, Yale, launched a capital gifts campaign to raise $370 million from the private sector in just three and a half years.[6] Stanford University has had a well-managed, five-year, $300 million campaign underway since 1972 and, in 1974, New York University announced its drive to raise $300 million in seven years.[7] These amounts are far greater than even the "optimistic" projected needs of our program to support an additional 20-30,000 minority students in engineering colleges over a nine-year period. Moreover, in the single year 1973-74, there were at least ten universities whose individual fund-raising efforts brought in over $27 million *each* in private funds[8]—much more than our "optimistic" average requirement of $23.9 million per year for the next nine years.

The fact that the new funds we are calling for are lower than the amounts now being raised by individual universities, convinces the Task Force that our goals are realistically attainable. Drawing upon the experience of the successful development programs of the major universities, a centralized, highly-focused fund-raising campaign seems called for to successfully raise such substantial sums. It will require a staff as large as ten professionals, as we have estimated, plus the full assistance and support of a powerful governing board and of the many corporations which have expressed a concern for the problem we are attacking.

INFLATION

As noted earlier we have made our projections in 1974-75 and 1975-76 constant dollars so as to keep our computations as simple as possible. To satisfy those who can cope with inflated dollars, we show in Table 6-19 the total program costs (in millions of dollars) as we have developed them, and as they would be affected by a 5 percent annual inflation rate after 1975-76 on all elements.

TABLE 6-19

Total Need for New Resources: Constant and Inflated Dollars

(millions)

Year	Conservative Projection		Optimistic Projection	
	CONSTANT DOLLARS	INFLATED DOLLARS	CONSTANT DOLLARS	INFLATED DOLLARS
1974-75	$ 5.971	$ 5.971	$ 6.691	$ 6.691
1975-76	8.434	8.434	9.905	9.965
1976-77	11.069	11.622	14.011	14.712
1977-78	13.865	15.286	18.940	20.881
1978-79	16.972	19.647	24.515	28.379
1979-80	20.165	24.511	30.074	36.555
1980-81	22.508	28.727	34.167	43.607
1981-82	24.430	32.739	37.231	49.893
1982-83	25.658	36.103	39.229	55.199
	$149.072	$183.040	$214.763	$265.822

Appendixes

APPENDIX A

Members of the Planning Commission

The Planning Commission for Expanding Minority Opportunities in Engineering is an *ad hoc*, independent Task Force representing a broad constituency. The members of the Task Force and their institutional affiliations are listed here. While the experiences and perspectives of the members' affiliations and constituencies have certainly influenced the preparation of this report, the conclusions and recommendations of the Task Force are those of the members alone and do not necessarily reflect those of their organizations.

Louis Padulo, *Chairman*
Associate Professor of Electrical Engineering
and Director of the Special Opportunities Program
Stanford University
Stanford, California

Pepe Barron
Director, Office of Spanish Speaking Fomento
American Association of Community and Junior Colleges
Washington, D.C.

Calvin H. Conliffe
Chairman, Minority Engineering Education Effort (ME^3)
and Consultant
Corporate Educational Relations
General Electric Company
Bridgeport, Connecticut

Donald G. Dickason
Assistant Dean of Engineering
and Director, Student Personnel
Cornell University
Ithaca, New York

David E. Ford
Manager, Industrial Control Product Development
Allen-Bradley Company
Milwaukee, Wisconsin

Austin E. Greaux
Chairman, Council of Deans of Predominantly Black Schools
and Dean of Engineering
Prairie View A & M University
Prairie View, Texas

David B. Kent, Jr.
Executive Director
National Scholarship Service and Fund for Negro Students
New York, New York

W. Edward Lear
First Vice President, American Society for Engineering Education
and Chairman, Engineering College Council of ASEE
and Dean, College of Engineering
University of Albama
University, Alabama

Delano Meriwether, M.D.
White House Fellow 1973–74
and Special Assistant to the Secretary, HEW
Department of Health, Education and Welfare
Washington, D.C.

Joseph E. Milano
Program Director, Research and Engineering Manpower Development
International Business Machines
Armonk, New York

Micah H. Naftalin
Executive Director
Assembly of Engineering
National Research Council
Washington, D.C.

David R. Reyes-Guerra
Executive Director
Engineers' Council for Professional Development
New York, New York

Lindon E. Saline
Chairman, Minority Committee of the Institute of Electrical and Electronics Engineers
and Manager, Corporate Education Services
General Electric Company
Management Development Institute
Ossining, New York

Willis Sprattling
Vice President, Product Evaluation & Services Department
Information Technology Group
Xerox Corporation
Rochester, New York

Clement W. Theobald
Vice Chairman and Executive Director, Dupont Committee on Educational Aid
E. I. du Pont de Nemours & Company
Experimental Station
Wilmington, Delaware

Seth H. Washburn
Executive Director, Salary and Technical Personnel Administration Division
Bell Telephone Laboratories
Murray Hill, New Jersey

John C. Williams
Professional Associate
Committee on Minorities in Engineering
National Academy of Engineering
Washington, D.C.

APPENDIX B

A Survey of Minority Engineering Programs

To more accurately assess the current status of minority participation in engineering programs, the Task Force conducted a mail and telephone survey of 35 colleges and universities which together produce more than 60% of the Black engineering graduates in the United States. The schools polled included:

1. Nineteen predominantly Black colleges which offer either a B.S. in engineering or else have provisions for a 3–2, or dual degree, program in cooperation with an engineering college; and
2. Twenty-one predominantly white engineering colleges, including the ten top colleges in terms of the number of minority graduates in 1972, and all those colleges that announced their programs in the N.A.E. Symposium in May 1973.

The predominantly Black colleges surveyed were:

The 4 Atlanta University Center Colleges	North Carolina A&T Univ.
Fisk University	Prairie View A&M Univ.
Hampton Institute	Shaw University
Howard University	Southern University
Le Moyne-Owen College	Tennessee State University
Lincoln University	Tougaloo College
Morgan State College	Tuskegee University
Norfolk State College	Xavier University

Of the fifteen schools listed above, six offer a B. S. degree in engineering. These are:

Howard University	Southern University
North Carolina A&T Univ.	Tennessee State
Prairie View A&M Univ.	Tuskegee University

Of the remaining nonengineering schools all but one, LeMoyne-Owen College, have working a 3–2 program with schools that offer a B.S. degree in engineering. In addition, of the many Black schools not surveyed, two have just started 3–2 programs: Grambling College with Louisiana Tech and Wilberforce University with the University of Dayton. Bishop College (with Southern Methodist), North Carolina Central University and Rust College (with Georgia Tech), and several other Black liberal arts colleges not surveyed have standing dual degree programs with engineering colleges. These programs are often run through the physics or math departments, but some schools actually have a "Pre-engineering" department where a student can take his math and early engineering courses. Therefore, there are about twenty-one predominantly Black schools which a student can attend to pursue a B.S. degree in engineering.

During the last five years the Black schools have had increased difficulty in recruiting students. Before that time predominantly Black colleges were practically the only places that Black students could go to college. But along with the affirmative action programs and more open admission policies of white schools over the past five years, the number of students attending predominantly Black schools has dropped steadily.

Some of these schools, Howard University and Tuskegee University, for example, have started recruiting very heavily. Their tactics have included contacting not only guidance counselors, but also science and math teachers from high schools. Often a student will express an interest in science to his science teacher, although his overall grades are not high enough for his counselor to spot him immediately as a college candidate.

Some colleges have sent recruiters to high school faculty meetings to stress the need for engineers. Science Fairs and Career Days on campus have also been developed to recruit minority students for engineering.

The lists from the National Scholarship Service and Fund for Negro Students (NSSFNS) and the Minority Engineering Education Effort (ME^3) have been used to widen the pool of students available to the colleges.

Although these programs have been creating better relations between the colleges and high school students, and students have become more aware of opportunities in engineering, so that freshman enrollments increased during the last year, there is still room for many more students in these schools. Normal freshman classes range from 75 to 100 students in the engineering schools, and schools range anywhere from half to two-thirds full.

A small amount of recruiting is also done by alumni. In these predominantly Black schools the major criteria for admission are high school grades and teacher recommendations. At most of these schools, SAT scores are not considered at all. In cases where SAT scores are considered, the average low admission point is 600 total. In some cases where both grades and test scores are low, a personal interview is used to determine whether a student's interest is genuine.

Once a student has been accepted in engineering and decides to attend one of these schools, he usually has the option of attending a pre-freshman summer session. These sessions usually last from 8 to 10 weeks and the student will study algebra, trigonometry, physics, and sometimes analytic geometry. At some

schools these programs are sponsored by industry, but at most schools students must pay their own way. This financial obstacle keeps many students who need them from attending these sessions.

Once a student has matriculated into a school, he has tutoring help available to him throughout his academic career. The typical retention rate at predominantly Black schools in engineering is between 70 and 75%, much higher than national averages for engineering colleges.

A typical minimal student cost figure for these schools for the 1973–74 school year was $2,300. This included $1,200 for tuition, $800 for room and board, $100 for books and $200 for incidental living expenses. Parents' confidential forms are used to provide financial aid of some sort. These financial packages include SOG and BOG grants and also loans. All financial aid is handled from university financial aid offices.

In Tables B-1 and B-2 detailed responses by schools of the predominantly Black colleges surveyed are shown.

TABLE B-1

The Six Black Engineering Colleges

SCHOOL	MINIMAL COST/YR.	REQUIRED SAT TOTAL	3-2 PROGRAM	FRESHMAN CLASS 1973	CLAIMED RETENTION
Howard University	$2,000	650	Yes	70	65%
North Carolina A&T	$2,800	800	Yes	100	75%
Prairie View A& M	$1,800	600	Yes	85	65%
Southern University	$2,000	600	Yes	100	70%
Tennessee State	$2,079	ACT (18)*	Yes	85	60%
Tuskegee Institute	$2,400	650	Yes	75	80%

*An ACT (18) corresponds roughly to a 600 SAT.

The predominantly white colleges surveyed included:

University of Alabama
University of Bridgeport
Univ. California-Berkeley
Carnegie Mellon
Case Western Reserve
University of Delaware
Drexel University
Georgia Tech
University of Houston
University of Illinois
University of Kansas
University of Michigan
University of Mississippi
Newark College of Engineering
New Mexico State College
City University of New York
Ohio State University
The University of Pennsylvania
Pratt Institute
University of Raleigh
Stanford University

TABLE B-2

Black Colleges Offering 3-2 Programs Leading to a B.S. in Engineering

SCHOOL	MINIMAL COST/YR.	REQUIRED SAT TOTAL	3-2 PROGRAM PARTNER	FRESHMAN CLASS 1973	CLAIMED RETENTION
Atlanta University Center Colleges	$2,850	500	Ga. Tech	100	80%
Fisk University	$2,300	700	Vanderbilt	30	40%
Hampton Institute	$2,660	500	Geo. Wash. U.	125	*
LeMoyne-Owens	$1,500	Not Reqd	Not operational yet	–	–
Lincoln U.	$2,300	700	Drexel U.	35	60%
Morgan St.	$2,300	700	Howard U	20	70%
Norfolk State	$2,000	500	Old Dominion	60	75%
Shaw University	$2,500	700	Ga. Tech. Univ. Mich.	70	50%
Tougaloo College	$2,400	600	U. Miss.	60	90%
Xavier College	$2,320	600	Notre Dame Tuskegee Marquette	9	95%

*Program has not been in operation long enough to compute percentages.

All of these schools offer at least a B.S. degree in engineering.

During the last five years many predominantly white colleges have begun to recruit more minority students diligently. Affirmative action programs have sprung up at many schools with the hopes of attracting minorities to them. Engineering departments, faced with lower enrollments since the engineering layoffs in the late sixties, have often sought minority students to fill their depleted ranks.

Recruiting techniques utilize not only teachers and guidance counselors, but also high school assemblies with slide shows and films, Science Fairs, and College Career Days. An increasing amount of recruiting is done on the junior college graduate level.

The lists from ME³ and NSSFNS are also employed by these schools, but because most of them are state institutions, they restrict recruitment geographically in order to avoid out-of-state fees and extra tuition for students.

The criteria for admission are often much tougher and more strictly observed than in the Black schools. Many schools require that the minority student be in the upper one-third of his graduating class *and* have an 800 total on the SAT. The average ACT score necessary is 18. Along with this "low" score for

SAT's, most schools require at least a 480 to 500 in math alone. Recommendations of high school teachers are used in conjunction with the other materials when SAT scores reach the "bottom" levels.

Recruitment programs have been moderately successful. From an average pool of 100 interested people, about 25 prospective students will apply, with 15–20 being admitted and actually coming. Most schools do not envision many prospects for increasing the size of their programs.

All schools contacted had some type of summer program in progress for minority students. The average program is eight weeks and offers trigonometry, analytic geometry, and either physics or chemistry. It is usually supported by contributions from large industries. Because there is no real financial deterrent, most minority pre-freshmen attend these sessions.

Once a student has entered the school as a freshman, he has tutoring help available to him throughout his academic career. Notwithstanding, the attrition rate from these engineering colleges ranges from 50% to 90%. About 30–50% of those leaving engineering do not drop completely out of college but simply

TABLE B-3

Selected White Schools with Minority Programs in Engineering

SCHOOL	MINIMAL COST/YR. 1973	REQ'D. SAT	3-2 PROGRAM	FRESHMAN[1] CLASS 1973	CLAIMED RETENTION RATES
U. Alabama	$2,000	ACT (18)*	Plan to	22	**
U. Calif.-Berkeley	3,000	900	no	7	**
U. Bridgeport	3,800	700	no	18	20%
Carnegie-Mellon	5,000	850	yes	110	30%
Case-Western	4,700	1,000	yes	2	**
CUNY	--	not reqd.	yes	128	30%
Drexel U.	4,300	900	yes	30	18%
Georgia Tech.	3,200	700	yes	55	50%
U. Houston	3,200	800	no	2	**
U. Illinois-Chic.	2,500	ACT (18)*	yes	70	20%
U. Kansas	2,976	800	yes	15	70%
U. Michigan	4,500	500	yes	9	35%
U. Mississippi	1,900	500	yes	1	**
Newark C. Engrg.	2,100	870	no	47	75%
New Mexico St.	3,000	ACT (18)*	no	30	**
Ohio St.	3,000	700	no	35	95%
U. Pennsylvania	2,270	900	yes	3	20%

[1]Freshman numbers listed here are for minorities only.
**Program has not been in operation long enough to compute percentages.
*ACT (18) corresponds roughly to a 600 SAT score.

change their major to another field. Most of the white colleges polled offer a B.S. in Engineering in four years, but they report that the average length of time needed to complete the degree is closer to five years.

The typical minimal student cost figure for the 1973–74 school year was $3,700. This included $2,100 for tuition, $1,100 for room and board, $150 for books and $350 for personal expenses.

Parents' confidential forms are also used here for determining financial need. The number of minority students receiving financial aid in these schools approaches 100%. In most schools the financial packages are handled by the university's financial aids office, but some engineering schools also award "grants" to students entering the engineering school.

In Table B-3 are listed the responses by school of the predominantly white engineering colleges surveyed.

Notes and References

1

Summary and Principal Recommendations

1. The representation of Blacks, Chicanos, Puerto Ricans, and American Indians in engineering was calculated from John D. Alden, "Women and Minorities in Engineering," *Engineering Education*, Vol. 64, No. 7, (April 1974), pp. 498–501, 533, and from 1970 census data. Alden estimates that 1.2% of American engineers are Black and 0.55% are American Indian. He estimates that 1.6% are Spanish-surnamed, but in the U. S. population only about 66% of the Spanish-surnamed are Chicano or Puerto Rican (see Department of Commerce, Census of Population, 1970, Subject Report PC(2)-1C, *Persons of Spanish Origin*, Table 3) which would suggest only about 1.06% were in engineering. The total (1.2 + 0.55 + 1.06) is 2.81%. Representation in the U. S. population was obtained from Subject Report PC(2)-1C and two others, PC(2)-1B, *Negro Population*, and PC(2)-1F, *American Indian*.

2. The estimate of minority freshman enrollment in engineering is developed in Chapter 4. See Tables 4-4, 4-6, and 4-7.

3. Percentage changes were calculated from Donald G. Dickason "Financing the Commitment to Increase the Number of Minority Engineers," *IEEE Transactions on Education*, E-17, No. 1, (February 1974), table 5, p. 18.

4. Alden (Ref. 1), 498–501, 533. See also *IEEE Transactions on Education*, E-17, No. 1 (February 1974), pp. 3–7.

5. See the instructions developed jointly by the U. S. Equal Employment Opportunity Commission and the Office of Federal Contract Compliance of the U. S. Department of Labor, published in the EEO-1 report issued in January 1970.

6. *The New York Times*, 24 April and 30 April 1974.

7. J. Stanford Smith, "NEEDED: A Ten-Fold Increase in Minority Engineering Graduates," an address to the Engineering Education Conference, Crotonville, N.Y., 25 July 1972 (reprinted by the General Electric Company, Schenectady, N.Y., August 1972).

8. Calvin H. Conliffe, "Formula for Action: ME^3 = Minority Engineering Education Effort," *IEEE Transactions on Education*, E-17, No. 1 (February 1974), 37–43.

9. Frederick E. Terman, "On Engineers and Engineering," a talk delivered to the Palo Alto (Calif.) Rotary Club, 12 November 1973. Dr. Terman has been interested in engineering manpower for many years, and this talk distills ideas from his other presentations. See also, "Supply of Scientific and Engineering Manpower: Surplus or Shortage?" *Science*, 173, No. 3995, 399–405, and "Engineering Manpower for the Future," presented at the ASEE-RWI Conference, Stanford University, 8 February 1973.

10. See, for example: (1) U. S. President, 1968-74 (Nixon), *Manpower Report of the President, March 1972* (Washington, D.C.: U. S. Government Printing Office), p. 124; (2) *IEEE Manpower Report 1973: Career Outlook in Engineering* (New York: Institute of Electrical and Electronic Engineers, 1973), pp. 5, 39–116; and (3) U. S. Department of Labor, *Occupational Outlook Handbook*, 1974–75 edition (Washington, D.C.: U. S. Government Printing Office, 1974), as described by Selig S. Harrison in "Top Growth Seen in Professional Technical Fields," *Washington Post*, 7 April 1974.

11. *Engineering Manpower Highlights*, No. 225 (New York: Engineering Manpower Commission, Engineers Joint Council, November 1973) and *New Publications and Items of Manpower Interest* (New York: Engineering Manpower Commission, Engineers Joint Council, 17 May 1973).

12. U. S. President, 1968–74 (Nixon), *Manpower Report of the President, March 1973*, House Document No. 93-64 (Washington, D.C.: U. S. Government Printing Office), Table A-4, p. 131.

13. U. S. Department of Commerce, Bureau of Census *Social and Economic Status of the Black Population in the United States, 1972*, Current Population Reports, Series P-23, No. 46 (Washington, D.C.: U. S. Government Printing Office, 1973), Table 26, p. 38. It is interesting to observe that in the three hardest hit areas of Seattle, Washington, Orange County, California, and Wichita, Kansas, engineering unemployment reached record levels of 9.0, 7.4, and 7.1 percent respectively during the well-publicized aerospace cutbacks in 1971—levels well below the customary 10% unemployment figures for minorities (*Science Resources Studies Highlights* [NSF 71-26 and 33], as quoted in *The American Almanac 1974* (New York: Grosset and Dunlap, 1974), p. 530, Table 871). As Dean Percy Pierre of Howard University has commented, "If minority unemployment is 10% it is considered normal but if engineering unemployment changes from 1% to 3%, it's considered to be a national crisis."

14. *Engineering and Technology Enrollments* (New York: Engineering Manpower Commission of Engineers Joint Council, annual). See 1969, 1970, 1971, 1972, 1973, 1974 editions.

15. *Salary Survey: A Study of the 1973–74 Beginning Offers*, Report #2 (Bethlehem, Pa.: College Placement Council, March 1974).

16. Estimated by Task Force member Donald G. Dickason, utilizing data from a number of multidivision companies.

17. Robert N. Mills, "Placement and Advancement Opportunities for Minority Engineers," an address to the College Industry Conference, Relations with

Industry Division, American Society for Engineering Education, Clearwater, Florida, 14 February 1974 (reprinted by the General Electric Company, Ossining, N.Y., February 1974).

18. "The Demand for Engineers," *Engineering Manpower Bulletin*, No. 22 (New York: Engineering Manpower Commission, Engineers Joint Council, August 1972).

19. Terman address (Ref. 9).

20. From Gary Williams, assistant dean of the Stanford University Graduate School of Business, during a description for the Task Force of the program of the Council for Opportunity in Graduate Management Education (COGME), which provides fellowship funds for minority students attending graduate schools of business at ten leading institutions.

21. See Lindon E. Saline, "A National Effort to Increase Minority Engineering Graduates," *IEEE Transactions on Education*, E-17, No. 1 (February 1974), p. 1. This entire issue is available for a nominal cost from the Institute of Electrical and Electronics Engineers, 345 East 47th St., New York, N.Y. 10017.

2

The Progress of Minorities Through the Educational System

1. U. S. Department of Commerce, Bureau of the Census, *The Social and Economic Status of the Black Population in the United States, 1971*, Current Population Reports, Series P-23, No. 42 (Washington, D.C.: U. S. Government Printing Office, July 1972), Table 62, p. 80.

2. U. S. Department of Commerce, Bureau of the Census, *The Social and Economic Status of the Black Population in the United States, 1972*, Current Population Reports, Series P-23, No. 46 (Washington, D.C.: U. S. Government Printing Office, July 1973), Table 47, p. 61.

3. See *The Chronicle for Higher Education*, #9 April 1973, p. 1, Column 1. This misinterpretation uses the 1972 data from our Table 2-3 to conclude that Blacks who graduate from high school are almost as likely to go to college as white high school graduates. The table indicates, however, that the trend is not so clear-cut.

4. Alan Pifer, *The Higher Education of Blacks in the United States* (New York: Carnegie Corporation of New York, 1973), p. 29.

5. Fred E. Crossland, *Minority Access to College* (New York: Schocken Books, 1971).

6. *The American Freshman: National Norms for Fall 1973* (Los Angeles: Cooperative Institutional Research Program of the American Council on Education and the University of California at Los Angeles, 1973).

7. *The American Freshman: National Norms for Fall 1972*, ACE Research Reports, 7, No. 5 (Washington, D.C.: American Council on Education, 1972).

8. U. S. Department of Commerce, Bureau of the Census, *School Enrollment* Subject Report PC(2)-5A based on 1970 Census of Population (Washington, D.C.: U. S. Government Printing Office, April 1973), pp. 2 and 4. This is a rough estimate, assuming that the proportions of Blacks to the total population among those 15–17 years old in 1970 would remain about the same two and three years later, when these young people would be old enough to be college freshmen. A similar calculation using data from Table 4-10 of this report for those aged 15–17 produced an estimate of 13.2%.

9. Alexander A. Astin, *College Dropouts: A National Profile*, ACE Research Reports, 7, No. 1 (Washington, D.C.: American Council on Education, February 1972), pp. 17–19. Also on p. 41 Astin states: "So far as remaining in college is concerned, being Black is something of a liability in a two-year college but an asset in a four-year college or a university."

10. Alan E. Bayer, *The Black College Freshman: Characteristics and Recent Trends*, ACE Research Reports, 7 No. 3 (Washington, D.C.: American Council on Education, 1972). Also Crossland (Ref. 5, pp. 32 and 70–71, notes the increase in the proportion of Blacks entering two-year colleges.

11. Pifer (Ref. 4), p. 41.

12. William M. Boyd II, *Access and Power for Blacks in Higher Education: A Report on an Educational Policy Center Symposium* (New York: Educational Policy Center, July 1972), p. 16.

13. Crossland (Ref. 5), pp. 36–38.

14. Pifer (Ref. 4), p. 32.

15. Crossland (Ref. 5), pp. 38–39.

16. *Ibid.*, pp. 31–32.

17. These numbers are derived from Figure 2-1, which is explained later in this chapter.

18. Mario Obledo, Director of the Mexican American Legal Defense Fund, testifying before the U. S. Senate's Select Committee on Equal Educational Opportunity, 1970, as quoted in U. S. Commission on Civil Rights, *The Unfinished Education: Outcomes for Minorities in the Five Southwestern States*, Mexican American Educational Series, Report II (Washington, D.C.: U. S. Government Printing Office, October 1971), pp. 8–9.

19. U. S. President, 1968–74 (Nixon), *Manpower Report of the President, March 1973* (Washington, D.C.: U. S. Government Printing Office), Table 4, p. 94.

20. *Ibid.*, p. 94.

21. U. S. Department of Commerce, Bureau of the Census, *Persons of Spanish Origin in the United States, March 1973*, Current Population Reports, Series P-20, No. 264 (Washington, D.C.: U. S. Government Printing Office, May 1974), Table L, p. 9.

22. *San Francisco Chronicle*, 11 May 1974, p. 1.

23. "Task Force Report on Higher Education for Chicanos, Puerto Ricans, and American Indians" (an unpublished report of the Federal Interagency Committee on Education's [FICE] Task Force on Higher Education for Disadvantaged Minorities, April 1973), p. 16.

24. *Ibid.*, p. 15.

25. *The Unfinished Education* (Ref. 18), p. 5.

26. *Ibid.*, pp. 35–36.

27. *Ibid.*, pp. 36–37.

28. *Ibid.*, p. 38.

29. U. S. Commission on Civil Rights, *Toward Quality Education for Mexican Americans*, Mexican American Educational Series, Report VI (Washington, D.C.: U. S. Government Printing Office, February 1974), p. 67.

30. *Manpower Report of the President, March 1973* (Ref. 19), p. 88.

31. *Toward Quality Education for Mexican Americans* (Ref. 29), p. 98.

32. *Ibid.*, pp. 88–108.

33. Thomas P. Carter, *Mexican Americans in School, A History of Educational Neglect* (New York: College Entrance Examination Board, 1970), p. 118.

34. *The Unfinished Education* (Ref. 18), pp. 23–24.

35. *Toward Quality Education for Mexican Americans* (Ref. 29), p. 115.

36. *Manpower Report of the President, March 1973* (Ref. 19), p. 94.

37. *Ibid.*, pp. 93, 95.

38. *Ibid.*, p. 95.

39. *Ibid.*, p. 91.

40. *Ibid.*, p. 95.

41. "Task Force Report on Higher Education for Chicanos, Puerto Ricans, and American Indians" (Ref. 23), p. 18.

42. *Manpower Report of the President, March 1973* (Ref. 19), p. 94.

43. U. S. Department of Commerce, Bureau of the Census, *Puerto Ricans in the United States*, Subject Report PC(2)-1F, based on 1970 Census of Population (Washington, D.C.: U. S. Government Printing Office, June 1973), p. xi, Table 1 (United States and New York City), and pp. 37–38 (New Jersey and New York States).

44. "Task Force Report on Higher Education for Chicanos, Puerto Ricans, and American Indians" (Ref. 23), p. 20.

45. *Ibid.*, p. 20.

46. *Puerto Ricans in the United States* (Ref. 43), pp. 34, 102.

47. *1970-71 Annual Educational Summary* (Albany, N.Y.: University of the State of New York, State Education Department), Tables 9, 17–18, and 31; and *Racial/Ethnic Distribution of Public School Students and Staff in New York State, 1970–71* (Albany, N.Y.: University of the State of New York, State Education Department), Table 1.

48. "Task Force Report on Higher Education for Chicanos, Puerto Ricans, and American Indians" (Ref. 23), p. 21.

49. John K. Folger and Charles B. Nam. *Education of the American Population*, 1960 Census of Population Monograph (Washington, D.C.: U. S. Department of Commerce, Bureau of the Census, 1967), p. 57: "A student, even if he is from a family in comfortable circumstances, will usually not attend college unless he has prepared for entrance well in advance. Preparation can take at least two forms: choice of high school curriculum that is academically oriented, and nurture of motivation for college. Of course, some of those not so prepared do get to college, but they are quite unlikely to do so. Records of college attendance or nonattendance for high school graduates of the preceding summer were obtained in the fall of 1960 from high school principals in a national sample survey. About 7 out of 10 high school graduates who had been enrolled in a college preparatory curriculum, but only about 1 in 5 of those enrolled in some other curriculum, attended college in the fall of 1960."

50. Data supplied by the Bureau of Educational Program Research and Statistics, Board of Education of the City of New York. The information lists 150,282 Puerto Ricans "with little or no English language difficulty," which produces a total of 245,082 Puerto Ricans in all three categories. The citywide percentage of all students with moderate or severe English language difficulty was 14.1%.

51. "Task Force Report on Higher Education for Chicanos, Puerto Ricans, and American Indians" (Ref. 23), p. 19; and *Manpower Report of the President, March 1973* (Ref. 19), p. 90.

52. *The Fleischmann Report on the Quality, Cost, and Financing of Elementary and Secondary Education in New York State, I* (New York: The Viking Press, 1973), p. 50.

53. "Task Force Report on Higher Education for Chicanos, Puerto Ricans, and American Indians" (Ref. 23), p. 20.

54. *Report of the Fall 1973 Undergraduate Ethnic Census* (New York: the City University of New York, Office of Data Collection and Evaluation for the Vice Chancellor for Administrative Affairs), p. 6.

55. *Digest of Educational Statistics 1973* (Washington, D.C.: U. S. Office of Education, 1974), Table 13, p. 14, and Table 65, p. 54.

56. Arthur Blank, Margaret Knoefsky, Leonard Kogan, and Lawrence Podell *The Graduates Restudied: A Comparison of the Follow-Up of New York City High School Graduates of 1970 and 1971* (New York: The City University of New York, the Graduate School and University Center, Center for Social Research, September 1972), p. 101.

57. Folger and Nam (Ref. 49), p. 58: "College plans were almost as frequent among nonwhite as among white high school seniors. This finding would seem to run counter to other information about the educational attainment of whites and nonwhites, but it should be realized that school attrition occurs at earlier ages for the average nonwhite, and *those who reach the senior year of high school are an educationally select group.*" [Italics ours.]

58. David E. Lavin and Richard Silberstein, *Student Retention Under Open Admissions at City University of New York: September 1970 Enrollees Followed Through Four Semesters* (New York: City University of New York, Office of Program and Policy Research, February 1974), pp. 14–15.

59. U. S. Senate Committee on Labor and Public Welfare, Special Subcommittee on Indian Education, *Indian Education: A National Tragedy—A National Challenge*, Senate Report No. 91-501 (Washington, D.C.: U. S. Government Printing Office, November 1969), p. xi.

60. U. S. President, 1968-74 (Nixon), *A New Era for American Indians: The President's Message to the Congress of the United States on the American Indians, July 8, 1970* (Washington, D.C.: U. S. Department of the Interior, Bureau of Indian Affairs, 1970), p. 1.

61. U. S. Department of the Interior, Bureau of Indian Affairs, *Answers to Your Questions about American Indians* (Washington, D.C.: U. S. Government Printing Office, April, 1970), p. 2; and U. S. Department of Commerce, Bureau of the Census, *American Indians*, Subject Report PC(2)-1F based on 1970 Census of Population (Washington, D.C.: U. S. Government Printing Office, June 1973), p. ix.

62. *American Indians* (Ref. 61), p. 1.

63. *Statistics Concerning Indian Education, Fiscal Year 1973* (Lawrence, Kansas: Publications Service, Haskell Indian Junior College, January 1974, for the U. S Department of the Interior, Bureau of Indian Affairs, Office of Indian Education Programs), p. 1.

64. *Indian Education: A National Tragedy—A National Challenge* (Ref. 59), pp. 29–30.

65. *Ibid.*, pp. 59–60. Readers may see statements attributed to this reference to the effect that "Only 3 percent of Indian students who enroll in college graduate . . ." (p. xiii) and "For every 400 Indian students entering Federal high schools at the freshman level, only one will graduate from college" (p. 60). These statements are not consistent with those we quote, which are substantiated on p. 83.

66. Charles S. Owens and Willard P. Bass, "The American Indian High School Dropout in the Southwest" (Albuquerque, N.M.: Southwestern Coopera-

tive Educational Laboratory, January 1969, an unpublished experimental handbook), pp. 1, 5, 7, 17.

67. U. S. Commission on Civil Rights, *Socio-Economic Profile of American Indians in Arizona and New Mexico*, Staff Report #1, Albuquerque/Phoenix Hearings, November 1972, p. 10; "Task Force Report on Higher Education for Chicanos, Puerto Ricans, and American Indians" (Ref. 23), p. 29; and *Indian Education: A National Tragedy—A National Challenge* (Ref. 59), p. 60.

68. "Task Force Report on Higher Education for Chicanos, Puerto Ricans, and American Indians" (Ref. 23), pp. 30–32.

69. *Ibid.*, pp. 31–32.

70. *American Indians*, (Ref. 61), Tables I and II, pp. x-xi.

71. "Task Force Report on Higher Education for Chicanos, Puerto Ricans, and American Indians" (Ref. 23), p. 26.

72. *Indian Education: A National Tragedy—A National Challenge* (Ref. 59), pp. 27–28; and Patricia Locke, "Theoretical Construct of the Ideal School System for American Indians . . . Kindergarten Through Life" (Boulder, Colo.: Western Interstate Commission for Higher Education, April 1973, an unpublished paper), p. 5.

73. Locke (Ref. 72), p. 20.

74. *American Indians* (Ref. 61), p. ix.

75. Locke (Ref. 72), pp. 4–6.

76. *Statistics Concerning Indian Education, Fiscal Year 1973* (Ref. 63) pp. 1, 43.

77. *Indian Education: A National Tragedy—A National Challenge* (Ref. 59) pp. 196–197.

78. Locke (Ref. 72), pp. 2, 23.

79. *Indian Education: A National Tragedy—A National Challenge* (Ref. 59), pp. 24–25, 56–59, 65–66.

80. Locke (Ref. 72), pp. 7–29.

81. Owens and Bass (Ref. 66), p. 24, urge " . . . involvement of Indian tribal leaders and parents . . . to motivate students to acquire adequate training . . . ".

82. *Indian Education: A National Tragedy—A National Challenge* (Ref. 59), pp. 60–62.

83. *Ibid.*, p. 60.

84. *Ibid.*, p. xii.

85. *American Indians* (Ref. 61), Table 18, p. 192, Appendix 6.

86. *Indian Education: A National Tragedy—A National Challenge* (Ref. 59), p. 27.

87. *Ibid.*, p. xii.

88. "Task Force Report on Higher Education for Chicanos, Puerto Ricans, and American Indians" (Ref. 23), p. 29.

89. *American Indians* (Ref. 61), pp. xii-xvi.

3

Engineering Education and Minorities in Engineering

1. The 1965 report, *Factors Influencing Engineering Enrollment*, is available for $1.00 from ASEE, One Dupont Circle, Washington, D.C., 20036.

2. According to a 1973 poll by George Gallup as published in "My Son, the Lawyer—a Good Choice," *San Francisco Chronicle*, 3 December 1973, p. 18.

3. See Chapter 6 especially pp. 200–201 of John K. Folger, Helen S. Astin, and Alan E. Bayer, *Human Resources and Higher Education* (New York: Russell Sage Foundation, 1970).

4. Project TALENT is the first national census of aptitudes and abilities. It began in 1960, collecting data on 400,000 high school students in grades 9 through 12, and is designed to provide a 20-year-career follow-up. TALENT is now in its eleventh year of follow-ups and is directed by Marion F. Shaycoft and headquartered at P.O. Box 1113, Palo Alto, Ca., 94302.

5. William W. Cooley, "Vocational Interests," (a paper read at the Annual Meeting of the American Educational Research Association, New York, February 18, 1965), as quoted in Folger, Astin, and Bayer, *Human Resources and Higher Education* (Ref. 3), p. 213.

6. Folger, Astin, and Bayer (Ref. 3), p. 123. These two variables accounted for two-thirds of the weight in the career prediction equation.

7. *Ibid.*, pp. 214–215.

8. In "What's Different About Engineering Students," *Engineering Manpower Bulletin*, No. 24 (July 1973), Alden surveys a report by J. P. Lisack: *Changing Trends in the Plans of High School Seniors*, Manpower Report 73-1 (Lafayette, Ind.: Purdue University, February 1973).

9. *Engineering Education*, 64, No. 7 (April 1974) is the journal of the American Society for Engineering Education (ASEE).

10. Helen S. Astin, Elaine H. El-Khawas, and Ann S. Bisconti, *Beyond the College Years: Final Report on the 1971 Longitudinal Followup of 1961 and 1966 Freshmen* (Washington, D.C.: American Council on Education and Center for Human Services, September 1973), p. 80. It is also noted there that girls are experimenting too and that during the year between twelfth grade and one year out of high school the percentage of girls planning to be nurses dropped from 10.3% to 6.2%.

11. Folger, Astin, and Bayer (Ref. 3), p. 202.

12. Astin, El-Khawas, and Bisconti (Ref. 10), p. 81.

13. *Ibid.*, Table 59.

14. *Ibid.*, Table 60.

15. In their 1965 report cited in Ref. 1. Unfortunately things have not improved much with the passage of almost a decade.

16. The major EMC reports, *Engineering and Technology Graduates and Engineering and Technician Enrollments*, are published annually by, and available at cost from, Engineers Joint Council, 345 E. 47th St., New York, N.Y. 10017. The number of schools included in EMC survey varies slightly from year to year.

17. The present Engineering Student Retention Study is being directed by Dr. Edward Kraybill and his colleague Prof. Robert J. Foster, both of the Pennsylvania State University, and should begin releasing results in summer 1974.

18. The Cooperative Institutional Research Program (CIRP) is a national longitudinal study of the American higher educational system. Established in 1966 by the American Council on Education, the CIRP is now the largest ongoing empirical study of American higher education—involving data on more than 500 institutions, 100,000 faculty, and 2.5 million students. In order to maximize the utilization of these data in research and research training, responsibility for administering the CIRP was transferred in 1973 to the Graduate School of Education at the University of California, Los Angeles. The annual CIRP survey of entering freshmen is now administered from the Higher Education Laboratory at UCLA under continuing support and sponsorship of the American Council on Education. The number of colleges in the CIRP survey is taken from the USOE's *Education Directory*, and the number varies slightly from year to year.
The American Council on Education (ACE), founded in 1918, is a council of educational organizations and institutions. Its purpose is to advance education and educational methods through comprehensive voluntary and cooperative action on the part of American educational associations, organizations, and institutions.
The Higher Education Laboratory was established in 1973 as part of UCLA's Graduate School of Education. The Laboratory serves as an interdisciplinary center for research, evaluation, information, policy studies, and research training in the field of higher education.

19. See Fred E. Crossland, *Minority Access to College* (New York: Schocken Books, 1971), p. 8 for an idea of some of the uncertainty inherent in the data.

20. *The American Freshman: National Norms for Fall 1973* (Los Angeles: Cooperative Institutional Research Program of the American Council on Education and the University of California at Los Angeles, 1973), Table 3, p. 11, and p. 43; see also Ref. 18.

21. Starting with the report *The American Freshman: National Norms for Fall 1966*

through the latest norms for 1973, all numbers of students in the sample as well as the weighted national norms are gotten from the Table of "Samples and Weights Used in Computing National Norms." The percentages of students in the various categories are taken directly from the published tables of national norms.

22. The "lumping together" of the college and university pathways into the overall 4-year institution pathway of Figure 3-2 is accomplished in three stages: first we add the numbers of engineering freshmen in 4-year colleges and universities from their boxes in Figure 3-1 and write down their sum (30,156 + 36,762 = 66,918), on top of the lower right most box on Figure 3-2; second, we add the corresponding numbers from Figure 3-1, (591,286 + 382,943 = 974,229) to get the number of freshmen entering 4-year institutions to write on the box in Figure 3-2; finally, dividing the engineering majors by the freshmen (66,918/974,229 = 0.0686), and multiplying by 100, we get the percentage 6.9% to put inside the bottom right circle of Figure 3-2. Of course, we just subtracted the percentage of 2-year college entrants from 100% (100 − 40.9 = 59.1%) to see what percentage of entrants enrolled in 4-year institutions.

23. To get the percentage of 4-year institutional freshmen who enroll in engineering schools we divide the EMC figure for engineering school freshmen by [redacted] number on the 4-year institution box and multiply by 100: 51,925/974[redacted] × 100 = 5.3%. Subtracting the EMC Freshmen from our all 4-year freshmen yields the freshmen enrolling in non-engineering 4-year schools: 974,229 − 51,925 = 922,304.
Dividing the previously found 14,993 = 66,918 − 51,925 of those who plan majors in engineering, by the 922,304 freshmen in nonengineering 4-year schools we get 14,993/922,304 × 100 = 1.6%.

24. Robert J. Foster, "They Who Start in Engineering," a paper presented at the Annual Mid-Year Meeting of the Engineering Graphics Division of ASEE on January 25, 1974. Prof. Foster and Prof. Kraybill, both of Penn State, are directing the Engineering Student Retention Study of ASEE and ran a special tabulation on the freshmen engineering majors studied by Astin in his *College Dropouts: A National Profile*, ACE Research Reports, 7, No. 1 (February 1972).

25. From a one-year follow-up survey by Sandra Lutz of the American College Testing Program (ACT). See Table 2 of Lutz, *Do They Do What They Say They Will Do?* ACT Research Report No. 24 (March 1968).

26. Foster (Ref. 24).

27. Derived from Tables 1.12–1.14 of Bisconti and Astin, *Undergraduate and Graduate Study in Scientific Fields*, ACE Research Reports, 8, No. 3 (August 1973), pp. 32–34.

28. From a private communication from Alden and based on his experience at EMC (Ref. 16).

29. Based on estimates by Prof. James Wilson of Northeastern Univ., who conducts an annual survey of the (currently) 182 Co-op programs in engineering; about 22,310 of the EMC full-time undergraduate enroll-

ment of 186,705 are Co-ops. See also Co-op Education Association, *A Directory of Co-op Education* (Philadelphia: Drexel Univ., 1974).

30. *Factors Influencing Engineering Enrollment* (Ref. 1), Table 7.

31. See Table 1 of "Engineering Student Dropouts," *Journal of Engineering Education*, 50, No. 8 (April 1960). This article also surveys several previous attrition studies done by other organizations which found comparable successful engineering graduation rates of about 44% with only 33% finishing in 4 years.

32. Folger, Astin, and Bayer (Ref. 3), p. 95.

33. Published annually as *Engineering and Technology Enrollments* (Ref. 16).

34. The report "Survey of Factors Affecting Attrition in the College of Engineering at the University of Alabama," by Mr. Bill Christy, is available from the Dean of Engineering, University of Alabama, Tuscaloosa, Alabama.

35. See "Student Attrition—Is It Undermining Our Nation's Manpower?" *Journal of Engineering Education*, 53, No. 8 (April 1963), pp. 494–500.

36. See the article listed in Ref. 35 for the complete findings of this committee.

37. See Folger, Astin, and Bayer (Ref. 3), p. 95. Their report contains an insightful analysis of the engineering profession and shifts in student interest.

38. See F. N. Peebles, "Co-Operative Engineering Education—A Means for Meeting a National Need to Increase the Number of Black Engineering Graduates," and A. F. Hartford, Jr., "Using Engineering Related Employment to Supplement Engineering Education for Minorities," in *IEEE Transactions on Education*, E-17, No. 1 (February 1974), pp. 50–56. Also see E. H. Lyons and D. C. Hunt, "Cooperative Education—Evaluated," *Journal of Engineering Education*, 51, No. 5 (February 1961), pp. 436–443.

39. At the University of the Pacific, for example, Dean Robert Heybourne reports that in the four-year period since U.O.P. initiated their co-op program, their engineering enrollment has more than doubled with more than half of their new students coming from junior colleges.

40. See Ref. 29. In a poll of 150 companies employing large numbers of engineers conducted by Wyatt Isabel of Stanford University, 88% of the companies responding felt that co-op programs would be "useful" or "greatly useful," and 79% thought their own companies would be "likely" or "very likely" to participate in co-op programs for minority students. Interestingly enough, in that same survey, 83% of the companies said that contributing to minority engineering scholarship funds of a local school would be "useful" or "greatly useful," and 64% said their companies would be "likely" or "very likely" to make such contributions.

41. Henry H. Armsby, "Transfers to Schools or Colleges of Engineering 1951–53, 1959–61." The USOE survey was circulated as U. S. Office of Education Circular OE-54005-61-A of the Department of Health, Education, and Welfare (HEW). The survey results were reprinted for several

years by ASEE in their *Journal of Engineering Education;* the latest edition, as cited above, was published in JEE, 52, No. 10 (June 1962), pp. 679–683.

42. Published as Cooperative Research Project No. 1133 of the Center for the Study of Higher Education, University of California at Berkeley, 1964.

43. Published as Cooperative Research Project No. 2167 of the Center for the Study of Higher Education, University of California at Berkeley, 1964.

44. Knoell and Medsker found that of 7,243 total transfer entrants, in all majors, in 1960, only 39%, or 2,846, were able to graduate by 1962. By 1963, however, a total of 4,491, constituting 62% of the entrants, had earned bachelors degrees. Of the 7,243 entrants, 13% or 942 were engineers and, of these engineers, 199 (7% of the 2,846) graduated in engineering in 1962 while 362 (22% of the 1,645 = 4,491 − 2,846) graduated in engineering in 1963. Thus a total of 561 = 199 + 362 of the 942 transfers into engineering graduated within the three-year follow-up period. This corresponds to 21.1% (199/942 ×100) completion within 2 years and 38.4% (362/942 × 100) completion between 2 and 3 years and a total completion rate of 59.5% (561/942 × 100). The engineering transfers made up 13% (942/7,243 × 100) of the entering transfers and they made up 12% (561/4,491 × 100) of the total transfers who graduated within three years. These numbers appear in Report #2167 (see Ref. 43) in Tables 1, 3, and 7.

45. Knoell and Medsker, *Articulation Between Two-Year and Four-Year Colleges* (Ref. 43), p. 22.

46. Provost George Maslach at U.C. Berkeley, for example, has tracked transfer student progress for a decade. Assistant Dean W. J. Knapp of the UCLA School of Engineering and Applied Science reports: "... several studies have been made of students at both UCLA and U.C. Berkeley on this subject, and the results indicate that transfer students do equally well as native students. In fact, we are unable to distinguish between the two groups with respect to their grade averages, honors achieved, and other aspects."

47. Knoell and Medsker, *Articulation Between Two-Year and Four-Year Colleges* (Ref. 43), p. 56.

48. *Ibid.,* pp. 55–56.

49. See Table 12 of J. A. Creager, *The American Graduate Student: A Normative Description,* ACE Research Reports, 6, No. 5 (Washington, D.C.: American Council on Education, 1971), p. 11.

50. The Task Force gratefully acknowledges the assistance of Arthur Marmaduke, Executive Secretary of the California State Scholarship and Loan Commission, Sacramento, California, for making available raw data from 160,000 anonymous student responses from their Spring 1972 Survey of Student Resources, conducted by the College Entrance Examination Board (CEEB), and published as Report #1 of the Student Financial Aid Research Series.

51. Estimates were made by Donald Dickason of Cornell University from

reports by engineering admissions officers and deans at six eastern schools. The eleven member colleges of the Association of Engineering Colleges of New York Schools in their April 1974 meeting reported that for the third year in a row transfer student applications were running over 10% of their freshmen applications. This percentage of freshmen applications could easily amount to a third of the junior year engineering enrollment!

52. See Folger, Astin, and Bayer (Ref. 3), pp. 163, 175.

53. For general attitudinal and motivational studies of Indians, see Sheps, "Indian Youth's Attitudes Toward Non-Indian Patterns of Life," *Journal of American Indian Education*, 9 (January 1970), pp. 19–27; and Reboussin and Goldstein, "Achievement Motivation in Navaho and White Students, *American Anthropologist*, 68, No. 3 (1966).

54. The classic Black study is *A National Profile of Black Youth: The Class of 1971*, NSSFNS Research Reports, 1, No. 1 (New York: National Scholarship Service and Fund for Negro Students, 1972). NSSFNS maintains a National Office at 1776 Broadway, New York, N.Y. 10019, and a Southeast Regional Office at 965 Hunter St., N.W., Atlanta, Ga. 30314.

55. The report *Minority Youth: The Classes of 1972 and 1973*, NSSFNS Research Reports, 2, No. 1 (April 1974) has responses gathered from 41,275 Black seniors in the fall of 1971 and 38,139 *minority* seniors, of whom 97% were Black, in the fall of 1972.

56. *The American Freshman: National Norms for 1971*, ACE Research Reports, 6, No. 6 (Washington, D.C.: American Council on Education, 1971).

57. See Roy Wilkins' column "Here to Stay," *New York Post*, 29 April 1972, or David Kent's statement in "National Report Explodes Myths about Minority Students on College Campuses," in the *Twin Cities Courier*, Minneapolis, Minn., 6 April 1972. Hugh Lane's statement is reported in "Negroes Headed for College Found Sharing Many White Goals," *The Chronicle of Higher Education*, 6, No. 26, 3 April 1972. See also "A Sampling of Editorial Comments and Press Coverage" compiled by NSSFNS for some of the national reaction to the NSSFNS surveys (see Ref. 54).

58. A. E. Bayer, *The Black College Freshman: Characteristics and Recent Trends*, ACE Research Reports, 7, No. 3 (Washington, D.C.: American Council on Education, October 1972).

59. For example, David Kent of NSSFNS and Calvin H. Conliffe, Chairman of the Minority Engineering Education Effort; see "Formula for Action: ME^3 = Minority Engineering Education Effort," *IEEE Transactions on Education*, E-17, No. 1 (February 1974), pp. 37–43.

60. *The American Freshman: National Norms;* see Ref. 18.

61. See Ref. 16. The Black enrollment data are not considered by EMC to be as reliable as the general enrollment data because of poor reporting procedure by engineering colleges. The most recent year's data are felt to be the most reliable; and efforts are now under way by EMC to collect more accurate data on Blacks, Spanish-Surnamed Americans, American Indians, and Oriental Americans.

62. Reported in a private communication by Cesar De Leon, Deputy Director, Office of Pipeline Safety, Department of Transportation, resulting from his attempt to get some recent Chicano engineering graduates to serve on a panel discussion.

63. See *Mexican American (Chicano) Handbook of Affirmative Action Programs for Employers and Employees* (Downey, Calif.: Personnel Management Association of Aztlan [P.O. Box 4351], July 1973). Their estimates of Chicano graduates were obtained from an informal survey and contain several inaccuracies (i.e., their listings for Stanford University, University of New Mexico, and University of California at Santa Clara).

64. John D. Alden, "Women and Minorities in Engineering," *IEEE Transactions on Education*, E-17, No. 1 (February 1974), p. 5.

4

Educational Goals and Measures of Progress

1. This goal incorporates the same principles as those laid out in 1973 by the College Entrance Examination Board's Panel on Financing Low-Income and Minority Students in Higher Education. See the Panel's report, *Toward Equal Opportunity for Higher Education* (New York: College Entrance Examination Board, 1973), pp. 7–9.

2. Degree projections are made and updated every year by Martin Frankel, National Center for Educational Statistics, Department of Health, Education and Welfare (HEW), Washington, D.C. We subtracted their projections of Bachelor of Technology degrees from their published projections to get the engineering Bachelor's Degree projections in Column (2). See our Table 4-2.

3. U. S. President 1968–74 (Nixon), *Manpower Report of the President, March 1972* (Washington, D.C.: U. S. Government Printing Office, March 1972), p. 124.

4. As reported in the *Washington Post*, 7 April 1974.

5. As reported by John D. Alden of the Engineering Manpower Commission.

6. Charles F. Roos and Victor von Szeliski, "Factors Governing Changes in Domestic Automobile Demand," *The Dynamics of Automobile Demand* (New York: General Motors Corp., 1939), pp. 61–63. See also Thomas F. Dernberg, R. N. Rosett, and H. W. Watts, *Studies in Household Economic Behavior* (New Haven: Yale University Press, 1958), pp. 5, 45.

7. See the footnote to Table 5 of Donald G. Dickason, "Financing the Commitment to Increase the Number of Minority Engineers," *IEEE Transactions on Education*, E-17, No. 1 (February 1974), p. 18.

8. These estimates came from *Engineering and Technology Enrollments For 1969, 1971, 1972, and 1973* (New York: Engineering Manpower Commission, Engineers Joint Council).

9. *Minority Youth: The Classes of 1972 and 1973*, NSSFNS Research Reports, 2, No. 1 (New York: National Scholarship Service and Fund for Negro Students, 1974).

10. U. S. Office for Civil Rights, *1972–73 Public Elementary and Secondary Schools, Ethnic Composition of 12th Grade Student Population of 1972 Civil Rights Survey*, OCR File 72-458 (Washington, D.C.: U. S. Government Printing Office, 1972), p. 220.

11. See *The American Freshman: National Norms for 1973* (Los Angeles: Comparative Institutional Research Program of the American Council on Education and the University of California at Los Angeles, 1973).

12. *Engineering and Technology Graduates, 1973*, (see Ref. 8).

13. *Ibid.*

14. Percy A. Pierre, "Minority Graduate Education," *IEEE Transactions on Education*, E-17, No. 1 (February 1974), pp. 59–61.

15. See Table 1.21 of A. S. Bisconti and H. S. Astin, *Undergraduate and Graduate Study in Scientific Fields*, ACE Research Reports, 8, No. 3, (Washington, D.C.: American Council on Education, 1973), p. 40.

5

Mechanisms for Progress

No Notes

6

The Price Tag for Progress

1. U. S. Department of Commerce, Bureau of the Census, *Persons of Spanish Origin in the United States: March 1973*, Current Population Reports, Series P-20, No. 264 (Washington, D.C.: U. S. Government Printing Office, May 1974); Chicanos from Table I, p. 6; Puerto Ricans from Table J; p. 6. U. S. Department of Commerce, Bureau of the Census, *Social and Economic Status of the Black Population in the United States, 1972*, Current Population Reports, Series P-23, No. 46 (Washington, D.C.: U. S. Government Printing Office, 1973); whites and "Negro and Other Races" from Table 7, p. 17.

2. Donald G. Dickason, "Financing the Commitment to Increase the Number of Minority Engineers," *IEEE Transactions on Education*, E-17, No. 1 (February 1974), p. 26.

3. *Ibid.*, pp. 28–29.

4. According to estimates made by Dickason (see Ref. 2, pp. 25–29). This figure has been questioned by a number of Task Force members who believe it is low. This quite likely is the case due to inadequate reporting since there is no established mechanism for regular accumulation of such data. If industry contributions are indeed larger, as we suspect, and if a greater proportion of these funds are being channeled to minorities, then our figures in column 3 of Tables 6-18 A and B would go up, and overall need would be reduced accordingly.

5. See Ref. 2, p. 21.

6. Yale University News Release #116 (Yale University News Bureau) April 8, 1974. As of that announcement date over $63 million toward the goal had already been received or committed.

7. A Stanford University Memorandum, dated May 6, 1974 listed several other major campaigns: California Institute of Technology ($130 million/5 years); UCLA ($20 million/5 years); Duke University ($162 million/3 years); University of Southern California ($200–250 million/5 years); Case-Western Reserve ($200 million/5 years); University of Chicago, Cornell University and University of Pennsylvania, $250 million each.

8. According to the June 1974 issue of *Change* magazine, for the year ended last June 30, according to the Council for Financial Aid to Education (CFAE), contributions from individuals, corporations, and foundations reached a record high—$2.24 billion, an increase of 11 percent over the previous year. The top recipients were: Harvard, $57.1 million; Stanford, $46.5 million; University of California System, $44.3 million; Yale, $32.1 million; Cornell, $30.6 million; Northwestern, $30.3 million; University of Pennsylvania, $28.9 million; University of Chicago, $28.7 million; Emory University, $27.4 million; and Columbia, $27.1 million. Details are contained in *Voluntary Support of Education*, 1972–73, $6, (CFAE, 680 Fifth Ave., New York, N.Y. 10019).

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